Environmental Management, Inc.

JOB NO. ________ SHEET ________ OF ________

JOB NAME Cold test P.7 Spent.

BY Hudson DATE 8-Jan-99

CHECKED BY ________ DATE ________

STAF

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37/37

Bully Barn

5- 5gal buckets of ATF
1- 48" pipe WRENCH
4- 5gal buckets of USED OIL
3- 1gal Jugs of 15W-40
1- SCISSOR JACK CONTROL "4' Long"
1- CORE CABLE
4- SETS OF CLAMPS FOR DSE ENCLOSURE
1- Box misc. FOR DSE "3'x3'"
1- ATF HAND PUMP

YRT

17- PALLETS w/EMPTY BARRELS approx 4'x4' - 4 barrels EACH
1- 8' CORE STINGER
1- 5' CORE WEIGHT
1- BOX w/ CORE TOOLING 3'x4'
1- TRI POD STAND FOR INNER BARRELS 4' HIGH
1- SCISSOR JACK 1' x 3'
1- CORE WAGON 2' x 5'
2- DSE ENCLOSURES 4' WIDE x 3' TALL

YARD

1- SONIC HEAD STAND 4'x4'
1- PALLET W/ PROBE TOOLING
1- CORE WAGON

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TITLE:

Geophysical Logging

Approved By

J. J. Dorian, Program Manager
Environmental Monitoring & Investigations

1.0 PURPOSE

This section describes the geophysical logging and analyses conducted to detect the presence of sub-surface contamination and to monitor the operating condition of nearby nuclear and/or non-nuclear facilities.

2.0 SCOPE

This section applies to Environmental Monitoring and Investigations (EM&I) personnel involved with geophysical logging and provides the minimum requirements for obtaining borehole geophysical logging data for environmental investigation and site characterization.

3.0 REQUIREMENTS

3.1 POLICY IMPLEMENTATION

The Waste Management Federal Services, Inc., Northwest Operations (WMNW) Environmental Monitoring manual provides employees with clear, documented guidelines consisting of policies, work procedures, performance requirements, process or equipment operational limits, and rules of conduct.

3.2 EMPLOYEE COMPLIANCE

Compliance to these documents is required of EM&I employees. Errors or deficiencies in these documents should be promptly reported to EM&I. If implementation and compliance to an established policy requirement or procedure cannot be achieved, work shall be immediately and safely stopped. Responsible management should be consulted for direction to proceed.

3.3 CHANGE PROCESS AND CONTROL

Revisions will be reviewed and approved by the EM&I Program Manager annually or as needed. Corrections and/or needed changes to procedures can be implemented under field conditions by marking up field copies and acquiring verbal concurrence of Program Manager.

- [x] A WORK MAY PROCEED SUBJECT TO INCORPORATION OF COMMENTS
- [ ] B REVISE AND RESUBMIT WORK MAY PROCEED SUBJECT TO INCORPORATION OF CHANGES INDICATED
- [ ] C REVISE AND RESUBMIT WORK MAY NOT PROCEED
- [ ] D REVIEW NOT REQUIRED WORK MAY PROCEED

CONTRACT NO. S-C95-175003-1664
BY: Annette Kiehl
DATE: 12-7-99

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3.4 REPORTS

Results of geophysical logging are documented in reports identified in Section 6.0 (Records) of this procedure.

3.5 SAFETY AND SECURITY

Safe work practices shall be followed at all times.

3.6 LOGGING

Well Logging shall take place as directed by the appropriate Program Manager or other contractual customer when applicable. Repeat logging sections are to be 10% of the total well depth. The Spectral Gamma-Ray and optional passive neutron logging will be performed under operating procedures in Attachment A. Directional Gamma-Ray logging will be performed under operating procedures in Attachment H. The Logging Truck Depth Calibration will be performed as described in Attachment B. The HPGe calibration data collection will be performed as described in Attachment E.

Well log data are maintained in the designated manner and at places that satisfy protocols identified in Section 4.0. Data storage and security for raw log survey data will be maintained as described in Attachment C.

Completed well logs and data are archived at 345 Hills Street in Richland, Washington.

Quality control and acceptance criteria for the pre and post logging verification of the spectral instrumentation will be performed as described in Attachment D.

3.6.1 Contract Documents

In the event that WMNW utilizes sub-contract logging personnel or services for a given project the following requirements must be met.

1. When contracted logging is required for characterization work involving wells or boreholes, the logging geophysicist prepares the logging requirements to be included in or attached to the contract document.
2. The contractor must provide documentation of (and the cognizant manager or team lead must approve) logging technician training, expertise, and experience.
3. The contractor shall submit logging procedures to the WMNW logging geophysicist for approval.

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4. The work order/statement of work (SOW) should be delivered to the contractor two weeks prior to logging and shall contain at least the following requirements:

   a. Personnel qualifications and training.

   b. Instrumentation calibration methods.

   c. Preparation and submittal of logging procedures for WMNW approval prior to the start of work.

   d. Detailed special logging requirements, when applicable.

   e. Requirements for records maintenance and turnover to WMNW.

   f. List of deliverables, including number of wells and type of data (hardcopy/digital).

3.7 EQUIPMENT CLEANING/DECONTAMINATION

1. *Cleaning*: The logging cable shall be wiped with a 50% mixture of simple green and water and dried as the tool is withdrawn from the well. The tool may be wrapped with plastic sleeving. The cable wipes and sleeving shall be surveyed by a radiological control technician (RCT), unless previous arrangements have been made with an radiological control organization. Equipment cleaning shall be documented by signature on the Borehole Survey Data Sheet (Figure 1).

2. *Decontamination*: Decontamination of logging equipment shall be performed and documented in accordance the sections of SW-846 appropriate for the equipment being used for the logging work, or in accordance with directions supplied by the responsible radcon organization and/or applicable RWP

3.8 EQUIPMENT MAINTENANCE

3.8.1 General Logging System

When repairs are performed on any logging component, other than the borehole instrument, the system will be completely checked out in the shop. This means performing the prelog energy calibration/verification to determine if the system passes. If the component was a logging hoist or control component the system will be taken to a test hole to determine if the all systems function.

A notation in the logging system logbook shall be made upon completion of the repairs including information such a date, kind of repair, results of repair, data acquired during repair and person performing the repair and testing.

All repairs and maintenance shall be performed to the manufacturer manuals and specifications.

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Figure 1. Borehole Survey Data Sheet

BOREHOLE SURVEY DATA SHEET

Project:	Well Name:	Well ID:
Date:	Location:	

Notes: ______________________________

BOREHOLE LOGGING INFORMATION

Logger: ______________ Logging Unit Configuration: ______________

Depth Datum Reference: ______________ Instrument Calibration Configuration: ______________

Total Well Depth: ________ ft Source: ______________ Water Level: ________ ft Source: ______________

Source for Casing Parameters: ______________

Casing Diameter: ________ in. Wall Thickness: ________ in. Type of metal: ________ Total Depth: ________ ft Stickup: ________ ft

Diameter: ________ in. Wall Thickness: ________ in. Type of metal: ________ Total Depth: ________ ft Stickup: ________ ft

Diameter: ________ in. Wall Thickness: ________ in. Type of metal: ________ Total Depth: ________ ft Stickup: ________ ft

Diameter: ________ in. Wall Thickness: ________ in. Type of metal: ________ Total Depth: ________ ft Stickup: ________ ft

File Name Prefix: ________ Field Disk/Part. ________ Return Error: ________ in. (High/Low) at ________ ft Field Verifier ID: ________

Pre Log Verification: Gross ________ c/s Background ________ c/s Th 583 keV photo peak FWHM ________

Post Log Verification: Gross ________ c/s Background ________ c/s Th 583 keV photo peak FWHM ________

Log Interval: Fix Speed ________ fpm Move-Stop-Acquire ________ s (LT/RT)
Depth Range: Start ________ ft Stop ________ ft Incr ________ ft
Log Interval: Fix Speed ________ fpm Move-Stop-Acquire ________ s (LT/RT)
Depth Range: Start ________ ft Stop ________ ft Incr ________ ft
Log Interval: Fix Speed ________ fpm Move-Stop-Acquire ________ s (LT/RT)
Depth Range: Start ________ ft Stop ________ ft Incr ________ ft
Log Interval: Fix Speed ________ fpm Move-Stop-Acquire ________ s (LT/RT)
Depth Range: Start ________ ft Stop ________ ft Incr ________ ft

LOGGING OPERATIONS WERE PERFORMED AND EQUIPMENT CLEANED AS PER PROCEDURES, 17.0 GEOPHYSICAL LOGGING WASTE MANAGEMENT - NORTHWEST

Prepared by (print) ______________

Signature:

Date: ______________

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3.8.2 Borehole Instrument

When major repairs are performed on a borehole instrument, the instrument must be recalibrated per the calibration procedures. All repairs shall be per manufacturer documentation and standards.

All repairs to a borehole instrument shall be documented in a logbook for that instrument. The information included in this logbook is:

- Person performing the work.
- Lab notes and data during the repair and testing.
- Date and time.
- Detector serial number.
- Final test results confirming the repair is successful.
- Critical voltage and current reading.
- Potentiometer settings, such a gains and time constants.

4.0 RESPONSIBILITIES

4.1 QUALIFICATIONS

The logging geophysicist and logging technician must demonstrate training and qualification to the satisfaction of the cognizant program manager. Qualification of personnel shall be documented and the documentation maintained by the WMNW training coordinator.

4.2 LOGGING GEOPHYSICIST (SCIENTIST)

1. Oversee logging projects, and interface with field team leaders and project scientists/engineers.
2. Review draft remedial investigation plans or other plans involving subsurface investigations, and ensure that logging requirements are included in work plans or contract documents.
3. Prepare logging requirements for inclusion in contract documents (at a minimum, include the requirements of Section 3.6.1).
4. Review this instruction for applicability to new logging methods as they become available, and implement changes/revisions as required.
5. Prepare new logging procedures for review and approval as new methods become available, or revisions are required.
6. Verify that logging requirements will meet work plan objectives and goals.

4.3 LOGGING TECHNICIAN

1. Maintain and supply the logging equipment in a state of readiness.

2. Monitor equipment performance, and take immediate measures to correct problems.

3. Annually update Radiation Work Permits (RWP), safety documentation, and training and reading requirements. The Logging Technician does not have the responsibility or authority to update any of the specific documents that apply to INEEL Pit 9 work..

4. Stay apprised of changes in access to wells throughout the Hanford Site.

5. Maintain training to the level of Hazardous Waste Site Worker.

6. Ensure that logging and records disposition are performed in accordance with this procedure.

4.4 LOGGING ENGINEER

Provide engineering support encompassing the responsibilities listed in Sections 4.2 and 4.3.

5.0 FORMS

Borehole Survey Data Sheet (see Figure 1).

6.0 RECORDS

Record processing and disposition shall be performed in accordance with the following table.

Name (Filing Unit Title or Description)	Record Type	Retention Period	Disposal Authority	Cut-off and Retirement Instructions
Borehole Survey Data Sheet	QA	TBD	DRS 1.8f	Logging geophysicist transmits completed Borehole Survey Data Sheet to the FC. The FC copies the Borehole Survey Data Sheet and files (or transmits the copy to the appropriate file location) the copy in the project file, and transmits a copy to permanent storage per approved RIDS.
Calibration Certificate	QA	TBD	TBD	The original Calibration Certificate will be provided to the FC for transmittal to permanent storage per approved RIDS.
Data Storage	Record	TBD	TBD	Duplicate archival disks or other suitable data storage media will be provided to the FC and stored in record files.

FC = file custodian.
QA = Quality Assurance.
TBD = to be determined (dependant upon individual logging contract and project requirements).

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7.0 BIBLIOGRAPHY

API, 1974, *Recommended Practice for Standard Calibration and Format for Nuclear Logs*, RP 33, Third Edition, American Petroleum Institute, Washington, D.C.

ANSI, 1980, *American National Standard Calibration and Usage of Sodium Iodine Detector Systems*, ANSI N4212-1980, American National Standards Institute, New York, New York.

CASSAS Program Operations Manual, Greenspan Inc., Houston, Texas.

IAEA, 1982, *Borehole Logging for Uranium Exploration*, Technical Reports Series, No. 212, International Atomic Energy Agency, Vienna, Austria.

SW-846, 1986, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition*, U.S. Environmental Protection Agency, Washington, D. C.

WHC-SD-EN-TI-292, *Calibration of the Radionuclide Logging System Germanium Detector*, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-EN-TI-293, *Procedures for Calibrating Scintillation Gamma-Ray Well Logging Tools*, Westinghouse Hanford Company, Richland, Washington.

8.0 REFERENCES

HNF-PRO-453, *Environmental Notification and Reporting*, Fluor Daniel Hanford, Inc., Richland, Washington.

HNF-PRO-454, *Inactive Waste Sites*, Fluor Daniel Hanford, Inc., Richland, Washington.

HNF-PRO-455, *Solid Waste Management*, Fluor Daniel Hanford, Inc., Richland, Washington.

HNF-PRO-505, *Health Physics Procedures Manual, Appendix I*, Fluor Daniel Hanford, Inc., Richland, Washington.

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ATTACHMENT A. SPECTRAL GAMMA-RAY AND PASSIVE NEUTRON LOGGING.

1.0 APPLICABILITY

This attachment describes the minimum technical requirements for borehole spectral gamma-ray and optional passive neutron logging to be performed by WMNW. Spectral gamma-ray logs may be used to:

1. Delineate and characterize subsurface lithology.
2. Provide nondestructive, in-situ assays of gamma-ray-emitting radionuclides that are present in subsurface lithologic units (using HPGe instrumentation).
3. Provide nondestructive, in-situ relative indications of subsurface lithologic units using scintillator instrumentation.
4. Passive neutron logs may be used to identify the presence of fissionable radio-isotopes. Individual radionuclides cannot be identified.

Instrument field verification and operation instructions presented, conform as much as possible to the *Recommended Practice for Standard Calibration and Format for Nuclear Logs* (API 1974), as well as accepted uranium industry standards for spectral gamma-ray logging, *Borehole Logging for Uranium Exploration* (IAEA 1982).

2.0 DEFINITIONS

2.1 EQUIPMENT

Surface and subsurface equipment that operates a borehole detector under conditions of calibration supported configuration as defined on the geophysical logging system configuration.

2.2 PERSONNEL RESPONSIBILITIES

The logging geophysicist, or a logging technician, operates the logging equipment, ensures that the log data are properly recorded in an interim storage device, and ensures that the log data are transferred to a permanent mass-storage medium.

3.0 PROCEDURES

3.1 PREPARATIONS FOR LOGGING

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3.1.1 Safety

1. All geophysical logging conducted at active characterization or well construction sites shall comply with applicable project provided site safety plans (e.g., HASPs, HWOPs, etc.) and RWPs.

2. Logging conducted at remote work sites shall be conducted in compliance with the controls outlined in the Job Hazard Analysis specific for Site-wide geophysical logging.

3. Safety equipment may include steel-toed shoes/boots, hard hat, blue coveralls, leather gloves, eye and hearing protection, and two-way communication.

   a. Anti-contamination clothing may be required as directed by the RWP regulating the work site, or by the RWP specific to geophysical logging.

   b. Wells located within organic vapor zones must be surveyed with an organic vapor monitor (OVM) before being entered

3.1.2 Borehole Survey Data Documentation

Use the Borehole Survey Data Sheet to record pertinent information for each survey conducted.

3.1.3 Completing the Borehole Survey Data Sheet

1. If a particular data field is not applicable to a particular logging session, indicate by entering N/A in that field.

2. Make all log data entries with permanent black ink.

3. Line out corrections with a single line and place the correct entry as close as possible to the incorrect one. Initial and date the correction.

4. The Borehole Survey Data Sheet shall be signed and dated by the individual entering the information.

3.1.4 Calibration

A base calibration of the gamma-ray detection and recording systems is required once a year. The calibration shall be conducted at calibration models under U.S. Department of Energy (DOE) accepted standards (e.g., Hanford, Washington and Grand Junction, Colorado), or other NIST traceable secondary standards. A calibration is also required when system components are subjected to major repairs or alterations that change performance characteristics. The recalibration shall be prior to resuming logging activities or at the direction of the Program Manager after the repairs or alterations are completed.

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There are two spectral gamma ray detection systems, utilizing the HPGe and NaI types of detectors. These systems require different calibration data analysis, since they provide different quality log data. The NaI detector has significantly poorer energy resolution than the HPGe detector.

1. The NaI detector based logging systems will be calibrated as described in *Procedures for Calibrating Scintillation Gamma Ray Well Logging Tools Using Hanford Formation Models*, WHC-SD-EN-TI-293, Rev. 0. The collected calibration data will be analyzed in the manner described in the referenced document. Results of the analysis will be written to a page (hereafter defined as "Calibration Certificate).

   The Calibration Certificate, containing the specified instrument calibration results, will contain the following information:

   - Unique system calibration configuration (includes the tool identification number and calibration system configuration).
   - Date calibration data collected.
   - Signature by person responsible for calibration analysis and the date of signature.
   - Equation, values of coefficients, and definition of units.
   - Energy limits for validity of coefficients.
   - Electronic file name(s) for archived calibration and analysis data.
   - Shaping and gain settings established by equipment engineer for optimum performance and documented in log book.

   The original Calibration Certificate, along with any additional information pertinent to the calibration, will be processed as directed in Section 6.0 of this procedure. Copies of the Calibration Certificate will be retained in Geophysics' Investigations files, and on board the logging system defined in the Calibration Certificate.

2. The HPGe detector based logging systems will be calibrated as described in *Calibration of the Radionuclide Logging System Germanium Detector*, WHC-SD-EN-TI-292, Rev. 0. Data for the HPGe detector calibration shall be collected per the instructions in Attachment E. The collected calibration data will be analyzed in the manner described in the referenced document. Results of the analysis will be written to the Calibration Certificate. The Calibration Certificate for the HPGe instrument will contain the same type of information as listed above for the NaI instrumentation.

3. The passive neutron detector (optional instrumentation) is operationally verified by the Electronics Engineer in the geophysics laboratory prior to deployment for a project. The

detector electronics records activity in counts per second and is not calibrated for varying environmental conditions or specific isotope concentrations.

3.1.5 Elevation Datum

Tool reference zero shall be the top of casing, except at drilling/well construction sites. At these sites, the tool zero reference shall be the estimated ground surface. The method of determining ground surface shall be documented on the Borehole Survey Data Sheet on the "Depth Datum Reference" line, and subsequent surveys shall use the same method.

1. Casing specifications shall be determined and recorded on the Borehole Survey Data Sheet, and the source shall be provided. At active sites, where ground surface is estimated, the casing stickup shall be recorded.
2. If water is present in the borehole, the level will be determined from top of casing by use of an electrical water detection tape and recorded on the Borehole Survey Data Sheet. If the water level is obtained from another source, the source shall be recorded.
3. Total depth of the borehole shall be recorded along with source of reference. If field measurement is not appropriate than as built drawing will be utilized.

3.2 FIELD OPERATIONS

3.2.1 Prerequisites

Open boreholes drilled, or existing, in areas where radioactive contaminants are known or suspected to exist in the subsurface shall be checked by swab test prior to logging. Informational well logs or well services databases can be utilized to fulfill this requirement. The swab shall be surveyed for radioactive contaminants by an RCT.

3.2.2 Equipment Setup

1. Position logging truck to access well with logging tool.
2. Swing logging cable suspension boom to rear of truck.
3. Connect logging cable to logging tool.
4. Place logging cable over boom sheave wheel.
5. Suspend logging tool via cable over sheave wheel.

6. Turn power on to instrument.

3.2.3 Program Startup

1. Start computer logging control program per CASSAS procedures manual. Select software data collection configuration appropriate for spectral gamma-ray detector type and optional passive neutron detector. Depth difference between the center of primary detector (spectral gamma-ray) and secondary detector (passive neutron) is maintained in software initialization files.

2. Enter required information to access "initialization and calibration" screen.

3.2.4 Prelogging Energy Calibration

1. Attach field verifier to logging tool at preselected location. Field verifier emits gamma-rays with no neutron emissions.

2. Collect energy-calibration spectra (300 sec.).

3. Execute energy-calibration sequence per CASSAS procedures manual. Record gross count rate on Borehole Survey Data Sheet.

4. Remove field verification source and place in side storage compartment (normally locked) next to stars leading to logging cabin.

5. Perform a background data collection and record this gross on survey data sheet (300 sec.).

6. Measure the FWHM of the 583 keV photo peak using FVERFY program (Attachment F).

7. If FWHM is higher than acceptance (Quality Control [QC] Acceptance Criteria) then allow tool to continue electronic warm up for 10 minutes and repeat test. If this second value of FWHM is also larger than acceptable, then make adjustments to instrumentation gain settings and allow 10 minutes before taking a third measurement. If the third FWHM is also larger than acceptable, then, replace instrument with another and restart logging procedures; notify maintenance engineer of instrument failure.

8. Record successful FWHM value on survey data sheet.

9. The performance of the passive neutron detector (optional) shall be verified prior to project logging activities at a minimum. The neutron source contained in the shipping cask shall be used to verify the performance of the neutron passive detector.

10. Place the source cask next to the passive detector as it hangs off the logging boom.

11. Collect neutron spectra for 300 seconds. The neutron spectrum is MCB 2 of the logging

system.

12. Compare the shape of the acquired spectra to the example spectra in figure 1.

13. If the shape compares (not intensity), the peak is between channel 300 and 330 and lower level threshold is between channel 27 and 33 the detector operation is verified. The upper and lower thresholds for the spectral response should be visible, and if not then adjustment of the gain and offset must be performed until this condition is achieved. If such adjustments cannot generate the required spectral shape within 5 adjustments, then, end logging operations and send the instrument to repair.

14. ~~Save the acquired spectra as a pre-calibration file (*.CAB) for the neutron channel.~~

15. Place neutron source cask back in its proper storage area.

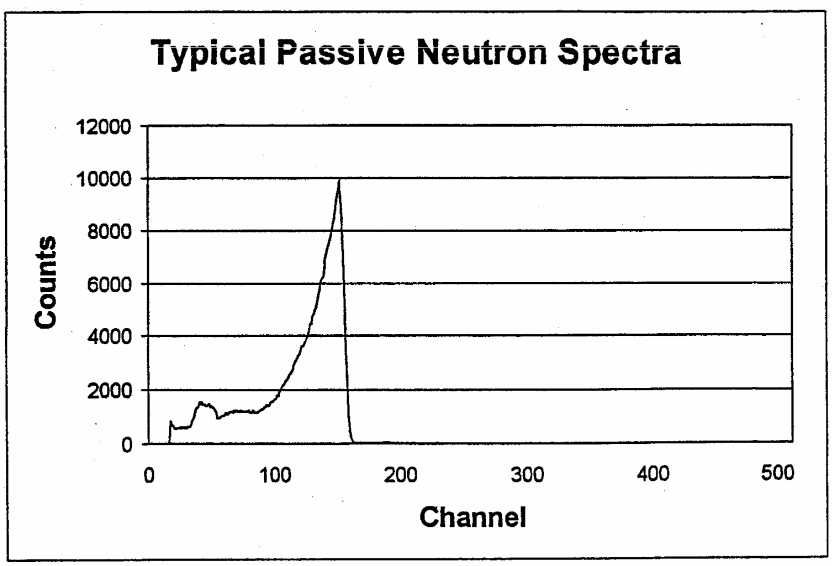

Figure 1. Example Spectra

3.2.5 Logging

1. Cover logging tool with plastic sleeve (as appropriate).

2. Attach logging tool centralizer when the inside diameter of the casing is greater than 4.5 inches.

3. Position logging tool over borehole.

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4. Position logging tool at "zero" position. (Center of primary detector (gamma-ray) is located at depth reference datum or as directed by the logging geophysicist.) Record any special conditions or directions on Borehole Survey Data Sheet (BSDS).

5. Enter logging parameters into computer for automated measurement sequence.

6. Position tool and collect spectra.

7. Position tool and re-log at least five (5) data points and/or 10% of original logging distance, or as directed by the logging geophysicist using the same acquisition mode and logging parameters as used for the survey.

8. Have cable, tool sleeving, and tool surveyed for radioactivity upon completion of logging in each borehole, unless previous arrangements have been made with an RCT, or project specific RWP.

3.2.6 Post Logging Performance Verification

Shall be conducted as described in Section 3.2.4. Energy calibration sequence (3.2.4.3) is optional. Any deviations between the pre- and post- calibrations shall be recorded on the Borehole Survey Data Sheet. If logging operations will continue on adjacent borehole without turning off equipment power then post logging performance verification is optional.

3.2.7 Equipment Takedown

1. Exit computer logging program.

2. Transfer the recorded electronic file to the WMNW data storage files per "Data Storage and Security for Raw Log Survey Data" (Attachment C).

3. Record removable disk number and disk partition used on Borehole Survey Data Sheet.

4. Turn power off to instrument.

5. Place logging tool onto the tool rack in truck, disconnect from the cable, and secure.

6. Remove logging cable from boom sheave wheel.

7. Move boom forward to traveling position.

3.2.8 Logging Activities Conducted Within Surface Contaminated Areas

Movement of logging equipment into and out of contaminated areas (CAs) will be regulated in accordance with guidelines established for vehicle surveys from CAs. Special instructions pertaining

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to logging activities in contamination areas (e.g., dosimetry, personal protective equipment) are outlined in the RWP regulating geophysical borehole/well logging.

3.2.9 Records Disposition

When logging is completed, check the Borehole Survey Data Sheet to ensure that:

1. All information is entered, legible and correct.
2. Abnormalities, observations, and adjustments are recorded in the "Notes" section.
3. Name, signature and date are recorded.

The logging geophysicist processes the logging documentation sheets as specified in Section 6.0 (Records) of this procedure. A copy of the data acquired and processed will be made on a removable data storage disk. The data files will be retained in Geophysics' Investigations' files. The files will be secured (locked) and will have controlled access. Data files will be processed as described in Section 6.0 of this procedure.

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ATTACHMENT B. LOGGING TRUCK DEPTH CALIBRATION.

1.0 APPLICABILITY

This attachment describes the minimum technical requirements for depth calibrations of the logging truck to be performed by WMNW. Depth measurements are used in borehole logging to:

1. Identify the depths of and delineate subsurface radionuclides and lithology.
2. Perform periodic (time lapse) monitoring of subsurface conditions.
3. Deploy multiple logging instruments into the borehole for measuring various geophysical properties.

Instrument field verification and operation instructions presented, conform as much as possible to the *Recommended Practice for Standard Calibration and Format for Nuclear Logs* (API 1974), as well as accepted uranium industry standards for spectral gamma-ray logging, *Borehole Logging for Uranium Exploration* (IAEA 1982).

2.0 DEFINITIONS

2.1 EQUIPMENT

The depth calibration of the logging system cable hoist unit was performed by the equipment manufacturer (Greenspan Inc.) as part of the system assembly and check-out. The precision of the depth measurement system is controlled by the number of pulses per revolution that the depth encoding sheave wheel generates and its diameter (i.e., 2500 pulses per revolution and diameter of 14 in., yields 0.09 in. [0.0073 ft] per pulse). The accuracy of the system changes with the weight of the logging probe, the amount of cable in the borehole, the depth to water, the ambient temperature (coefficient of expansion of the strength member of the logging cable, kevlar), and the amount of "ride-up" that occurs as the cable passes over the sheave wheel (increasing the effective radius of the measurement wheel).

2.2 PERSONNEL RESPONSIBILITIES

The logging geophysicist, or a logging technician, operates the logging equipment, ensures that the log data are properly recorded in an interim storage device, and ensures that the log data are transferred to a permanent mass-storage medium.

3.0 PROCEDURES

3.1 PREPARATIONS FOR LOGGING

3.1.1 Safety

1. The geophysical logging for depth calibration will be conducted at existing wells and shall comply with applicable site safety plans (e.g., HASPs, HWOPs, etc.) and RWPs.

2. Logging conducted at remote work sites shall be conducted in compliance with the controls outlined in the Job Hazard Analysis specific for Site-wide geophysical logging.

3. Based on site-specific safety plan requirements, safety equipment may include steel-toed shoes/boots, hard hat, blue coveralls, leather gloves, eye and hearing protection, and two-way communication.

   a. Anti-contamination clothing may be required as directed by the RWP regulating the work site, or by the RWP specific to geophysical logging.

   b. Capped wells in known organic vapor/liquid contaminated areas must be surveyed with an organic vapor monitor (OVM) before being entered.

3.1.2 Borehole Survey Data Documentation

Use the Depth Calibration Data Sheet (Figure B-1) to record pertinent information for each survey conducted.

3.1.3 Completing the Depth Calibration Data Sheet

1. If a particular data field is not applicable to a particular session, indicate by entering N/A in that field.

2. Make all log data entries with permanent black ink.

3. Line out corrections with a single line and place the correct entry as close as possible to the incorrect one. Initial and date the correction.

4. The Depth Calibration Data Sheet shall be signed and dated by the individual entering the information.

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3.1.4 Calibration

A depth calibration is required when system components are subjected to major repairs or alterations that change performance characteristics. The recalibration shall be completed prior to log survey deployment or at the direction of the Program Manager after the repairs or alterations are completed. A periodic (annual) check of depth calibration will be performed as described below.

The borehole (well) to be used for performing depth calibration should be at least 250 ft deep with water depth greater than 230 ft. (Two suggested boreholes are 299-E33-21 or 299-E33-20.)

3.1.4.1 Equipment Needed for Depth Calibration.

A depth calibration is performed by a mechanical check of the depth coefficient using steel measuring tape. The following equipment is needed for a depth calibration:

- Steel tape in good condition , with no kinks or observable damage (minimum 250 ft).
- Tripod to support the steel tape.
- Pocket ruler or tape measure for measuring the distance from the top of casing to the depth marks on the steel tape.

The Calibration Certificate, containing the specified instrument calibration results, will contain the following information:

- Unique system calibration configuration (includes the truck identification number and calibration system configuration).
- Date calibration data collected.
- Signature by person responsible for calibration analysis and the date of signature.
- Depth coefficient before calibration initiates and new coefficient.

The original Calibration Certificate, along with any additional information pertinent to the calibration, will be processed as directed in Section 6.0 (Records). Copies of the Calibration Certificate will be retained in Geophysics' Investigations' files, and on board the logging system defined in the Calibration Certificate.

3.1.5 Elevation Datum

Tool reference zero shall be the top of casing. The casing stick-up above the top of the cement collar or ground surface shall be documented on the Depth Calibration Data Sheet.

1. Casing specifications shall be determined and recorded on the Depth Calibration Data

Sheet, and the source shall be provided.

2. If water is present in the borehole, the level will be determined from top of casing and recorded on the Borehole Survey Data Sheet. If the water level is obtained from another source, the source shall be recorded.

3. Total depth of the borehole shall be recorded along with source of reference.

3.2 FIELD OPERATIONS

3.2.1 Prerequisites

Boreholes drilled, or existing, in areas where radioactive contaminants are known or suspected to exist in the subsurface shall be checked by swab test prior to logging. The swab shall be surveyed for radioactive contaminants by an RCT.

3.2.2 Equipment Setup

The logging equipment is to be setup as if for a normal logging job (attach an instrument and warm up the electronics). The depth calibration activities are to be recorded on the Depth Calibration Data Sheet shown in Figure B-1.

1. Position logging truck to access well with logging tool.

2. Swing logging cable suspension boom to rear of truck.

3. Connect logging cable to logging tool.

4. Power instrument by turning NIM bin on.

5. Place logging cable over boom sheave wheel.

6. Suspend logging tool via cable over sheave wheel.

3.2.3 Program Startup

1. Start computer logging control program.

2. Enter required information to access "initialization and calibration" screen.

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3.2.4 Logging

Conduct activities to acquire measurements for performing a depth calibration as described on the Depth Calibration Data Sheet.

Figure B-1.
Geophysical Logging Truck Depth Calibration Data Sheet.

Date: ____________ Start Time: ____________ Start Temperature: ______________ End Time: ____________
Logging Truck ID: __________________________ Logging Detector: __________________________
Depth encoder coefficient (from 4th record of LOG.INI file): __________________________
Logger: ____________ Well Name: ____________ WID#: ____________ Depth Datum Reference: ____________
Water Level: ______________________________ Source: ______________________________
Total Depth: ______________________________ Source: ______________________________
Casing Diameter: __________ Casing Wall Thickness: __________ Total Depth: _________ Stickup: ___________
Boom height to top of casing: Before ______________________________ After ______________________________

Zero top of cable head at depth datum reference. Advance, under computer program control to depths listed below the record depth using steel tape. At bottom of well, do NOT reset computer depth to steel tape reading. Tape "0" of steel tape to exact position of top of cable head.

Depth Calibration (Steel Tape)

Target Depth	Computer Depth	Steel Tape Depth (Measured)
20'		
50'		
100'		
150'		
250'		
Bottom of Well		

Begin Wiping Cable as Tool is With drawn.

250'		
200'		
150'		
100'		
50'		
20'		
0'		

Return top of cable head to top of tallest casing [depth datum reference] and record return error. Return error ("-" high, "+" low): ______________________

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1. Cover logging tool with plastic sleeve (as appropriate).

2. Attach logging tool centralizer when the inside diameter of the casing is greater than 4.5 inches.

3. Position logging tool over borehole.

4. Position logging tool at top of cable head and "zero" logging system.

5. Enter logging parameters into computer for automated measurement sequence.

6. Position tool and start logging program.

7. Have cable, tool sleeving, and tool surveyed for radioactivity upon completion of logging in each borehole, unless previous arrangements have been made with an RCT.

3.2.6 Equipment Takedown

1. Exit computer logging program.

2. Copy files from computer to removable disk and verify the recording on the disk media.

3. Power instrument off.

4. Place logging tool onto the tool rack in truck, disconnect from the cable, and secure.

5. Remove logging cable from boom sheave wheel.

6. Move boom forward to traveling position.

3.2.7 Records Disposition

A depth calibration certificate will be generated that contains the initial depth encoder coefficient, the average depth coefficient from each of the calibration phases, and the new depth encoder coefficient shall be inserted into the logging truck software control file.

When logging is completed, check the Depth Calibration Data Sheet to ensure that:

1. All information is entered, legible and correct.

2. Abnormalities, observations, and adjustments are recorded in the "Notes" section.

3. Name, signature and date are recorded.

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The logging geophysicist processes the logging documentation sheets as specified in Section 6.0 (Records). A copy of the data acquired and processed will be made on a removable disk. The data files will be retained in Geophysics' Investigations' files. The files will be secured (locked), will be under fire protection conditions, and will have controlled access. Data files will be processed as described in Section 6.0 (Records) of this procedure.

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ATTACHMENT C. DATA STORAGE AND SECURITY FOR RAW LOG SURVEY DATA.

The methods used to store raw log survey data in digital form and maintain data security are described below.

Raw Log Survey File Format

The raw log survey data is recorded by the data acquisition (Logging) computer on high speed disk with one survey data spectra per file. The raw data files have a 3 character extension name of "CHN". The CHN file format was developed by EG&G Ortec (Oak Ridge, TN) and is described in "Maestro Software Operator's Manual" and other documents. Undefined fields in the Ortec CHN file format were defined and used by Greenspan, Inc. for use in the RLS logging truck software. The descriptions of the CHN file format as used by Greenspan are detailed in the CASASII user's manual (1994, Greenspan, Inc.; Houston, TX).

File Names

The CHN files are considered the raw data of the accumulated electronic pulses from the detector -pre-amplifier - multi-channel analyzer system. The name of each CHN file is unique and is composed of 8 characters plus the 3 character file name extension of "CHN". The structure (form) of the 8 character file name is "xzzzsnnn" or "xxzzsnnn", where:

The first four characters of the file name is called the "File Name Prefix".

"x or xx" - Identifies the logging unit (RLS-1, RLS-2, or RLS-3) and the detector type or special project reference number. The table below shows the current logging unit and detector assignments. Special project file reference names are not included in the table.

"zzz or zz" - Designates a numerical sequence number (beginning at 001 or 01 and incrementing to 999 or 99) for the log survey acquired with the specified logging truck and detector combination. The numerical sequence number is recorded in a bound log survey record book, or "lab" book, that is maintained by the logging technician.

"s" - Identifies the multi-channel analyzer number from which the detector responses (pulses) were recorded. If only one detector is present then "s" is "1". If multiple detectors are present (e.g. [a] Shielded HPGe-10% and CZT or [b] neutron moisture and gamma backscatter-gamma) then the multi-channel analyzer for the second detector is incremented to "2".

"nnn" - Designates the raw spectra files recorded during the borehole survey (beginning at 000 and incrementing to 999). The <u>B</u>efore and <u>A</u>fter detector responses recorded for field verification of the detector response are recorded as <u>CA</u>libration and <u>BA</u>ckground. (i.e. CAB, BAB, CAA, BAA).

Table of current file name prefix assignments.

Logging Truck	Detector Type	File Name Prefix
RLS-1	HPGe	A###
RLS-2	HPGe	B###
RLS-2	CPT	C###
RLS-2	Moisture	MS##
RLS-1	Moisture	MA##
RLS-3	Moisture	MB##
RLS-3	NaI	N###

Log Survey Record Book

A book is maintained with each logging truck for documenting the logging, calibration, and repair activities. Each borehole survey is recorded in the record book in chronological order with (at a minimum) the survey date, file name prefix (first 4 characters), borehole identification number, and logging technician name.

Borehole Survey Data Sheet

A borehole survey data sheet is completed for each borehole surveyed. Instructions on how to complete the Log Survey Data Sheet are provided in the Geophysical Logging Procedures. The Borehole Survey Data Sheet contains the borehole identification number, file name prefix, survey date, logging technician name, and other relevant information.

Logging Truck Computer System

The RLS logging trucks are equipped with two computers that are identified as the "Logging" computer and the "Data Management" computer. The Logging computer contains interface cards for communication with the multi-channel-analyzer, depth encoder, cable hoist motor, and the Data Management computer. The Data Management computer contains interface cards for communication with the printer, removable disk drive, and a network to the Logging computer. During the boot-up of both the Logging and Data Management computers windows operating system network drivers are activated that permits Data Management computer to access the disk partitions of the Logging computer without interrupting the execution of the LOG program on the Logging computer. However, it is strongly suggested, to decrease the possibility of data corruption, that the transfer of raw data files form the Logging computer to the Data Management computer be timed to not be coincident with the LOG program access (output) to the high speed disk drive.

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Flow of Raw Log Survey Data Files

Concurrent with the acquisition of borehole survey data, generally, the raw log data files are copied, at the direction of the logging technician, from the Logging computer disk drive to the Data Management computer disk drive. The gross detector count rate is extracted from the raw log survey data files for visual inspection by the logging technician. During this process, if unusual conditions are observed they are noted on the Log Survey Data Sheet and the unusual conditions may be selected for a repeat survey log.

After the log survey is complete, including post verification of system performance, all raw log data files are copied from the Logging computer to the Data Management computer. The WinZip program is executed on the Data Management computer to compress (ZIP) the raw data files into one file for transfer to the removable disk storage unit. The steps to execute WinZip are as follows:

Execute the WinZip program to create a ZIP file of all CHN files on the disk directory that match the selected file name prefix. The name of the ZIP file is "xzzzRAW.ZIP" where xzzz is the file name prefix assigned by the logging technician earlier.

Transfer of Raw Survey Data to Removable Disk

To transfer the ZIP'ed raw survey data to the removable disk the logging technician performs the following:

1. Name the disk partition on the high speed disk to represent the borehole identification name or number (8 characters max.)

2. Insert the removable disk into the drive unit.

3. Copy the ZIP'ed raw survey data file to the removable disk (maintain the disk directory names).

4. Verify the raw survey data file was copied to removable disk by manually ejecting the removable disk, re-inserting it, and examining the directory tree of the removable disk.

5. Copy files on removable disk to archive computer and Log Analyst computer.

6. After the log survey raw data files are processed and analysis files are recorded on the archive computer, delete the ZIP'ed raw survey data file on the Data Management computer, and delete the raw survey data files on the Logging computer.

ATTACHMENT D. Q/C ACCEPTANCE CRITERIA.

1.0 BACKGROUND

There are several issues pertinent to the acceptance criteria for the pre and post logging verification of the HPGe spectral instrumentation. First, the selected photo peak and sample time of the verification must have high precision in order to measure the photo peak Full Width at Half Maximum, FWHM. Second, the electronic status of the instrumentation is the deciding factor for the acceptance criteria. Third, even though the instrument may be operating within electronic tolerance, the larger FWHM degrades the minimum detection threshold.

2.0 SPECIFICATIONS

The verifier unit to be used for HPGe logging systems can be either the Coleman mantles or the Amersham KUT units. The 583 keV photo peak is to be measured for the FWHM given that the grose peak intensity is at least 1200 c/s. All of the present HPGe systems easily reach this intensity for 300 s sample time using the Coleman verifiers. This requirement insures the FWHM measurement, during the verification, yields acceptable precision.

The acceptance criteria shall be established for each instrument at the time of the last electronic maintenance. Each crystal has a different inherent best resolution, and the electronics can only at best deliver this inherent resolution. When the instrument is determined to be in operating condition, the value of the 583 keV FWHM is established by the maintenance engineer over the logging cable. The logging operations must then observe a FWHM in field conditions that is less than 1.5 times the maintenance established FWHM value. (For example, assume the lab established FWHM for the RLSG3.1 is 2.0 keV. Then the verification measurement for well B8486 on 12/1/97 yielded 2.24 keV, well below the criteria of 3.0 for this example.) If the FWHM value fails the above criteria, all data taken previous to this time and the last acceptable FWHM value must be recollected.

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ATTACHMENT E. HPGe CALIBRATION DATA COLLECTION PROCEDURES.

1.0 BACKGROUND

Calibration for the HPGe logging system methodology is described in *Calibration of the Radionuclide Logging System Germanium Detector*, WHC-SD-EN-TI-292. These procedures are then a check list for the logging operator that collects the data. Calibration data for the HPGe logging instruments can be collected at "KUT" models constructed and standards established by DOE, Grand Junction, Colorado. Several sets of models have been placed throughout the US. While the models at Hanford have experienced moving from Spokane and subsequent drying, their consistency as standards have been established with dual calibration at Hanford models and Grand Junction models.

The calibration activities do not include characterizations for "environmental" corrections that are considered to be caused by gamma transport and not specific to instrumentation. For example, casing thickness correction is a function of casing properties and the cylindrical geometry. Likewise, borehole size is not instrument dependent. Dead time correction is presently performed by the electronics, and will not change for the utilized electronic structure for dead times less than 40%.

2.0 COLLECTION PROCEDURES

2.1 GENERAL PARAMETERS

A minimum of two models are to be used for a complete data set. These are called: 1) T or thorium, and 2) U or uranium models or appropriate equivalent. Frequently used additional models include the K or potassium and Mix a combination of KUT. The Hanford models are labeled SBK, SBU, SBT, and SBM for each of the respective four models. Each model will be measured for 10 distinct spectra for statistical analysis. The collection time for each individual spectra depends upon the efficiency of the instrument. The following table contains the existing HPGe instruments and their required collection times.

Instrument	Individual Sample Time (seconds)
18% - RLSG1	750
35% - RLSG3	500
70% - RLSG4	300
10% - RLSG5	1000

Thus the RLSG1 series instruments will have 7500 seconds of data collection in each of the models.

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This high sample time is required in order to process the multiplicity of photo peaks that are required in order to establish the calibration efficiency as a function of energy.

The instrument is positioned in each model such that the center of the detector is in the center of the model. The 10%, RLSG5 instrument series contains two detectors, the HPGe and the CZT. This instrument is placed such that the mid point between centers of each detector is in the center of each model.

The borehole must be air filled during data collection. The depth of the borehole water below the detector undergoing calibration must be 2 ft or more.

3.0 PROCEDURES

The following procedures are only concerned with the requirements for calibration. The logistics of radiological coverage and safety are standard and not placed here.

3.1 START

1. Position unit for measurement in one of the models (the order of models is of no concern).
2. Setup unit for logging (only items required to apply voltage to instrument).
3. Connect instrument and allow to electronically warm up.
4. Finish unit set up as instrument warms up.
5. Record in log book water level in borehole.
6. Pump out water in borehole.
7. Before the first model data collection perform energy calibration (583.1 & 2614.5 keV photo peaks) and verification establishing pass fail on FWHM of 583 keV peak of verifier.
8. Establish depth reference zero point.
9. Lower instrument to required depth. The depth from top of casing to mid point of each calibration zone is marked at each calibration model.
10. Start logging program for at least 10 stationary readings of required sample time (see table above).
11. Record in log book file name(s) and/or ranges for specific model.

3.2 REPEAT (INTERMEDIATE) MODEL

Move to next model.

1. Record in log book initial water level in borehole.
2. Pump out borehole water if present.
3. Establish depth reference if different model.
4. Position instrument in center of new calibration zone.
5. Start logging program for at least 10 stationary readings of required sample time (see table above).
6. Record in log book file name(s) and/or ranges for specific model.

3.3 LAST MODEL

Move to next model.

1. Record in log book initial water level in borehole if at start.
2. Pump out borehole water if present.
3. Establish depth reference if different model.
4. Position instrument in center of new calibration zone.
5. Start logging program for at least 10 stationary readings of required sample time (see table above).
6. Record in log book name(s) and/or ranges for specific model.
7. After data collection remove tool to surface and perform end of day verification.
8. Archive all data and prepare one floppy copy for calibration analysis.
9. Rig down, refill calibration models with water, and return to shop.

3.4 INTERMEDIATE OPERATIONS

When a given model data collection begins, there is time to perform other duties. These include such items as pumping out the borehole water for the next model to be used. Filling the borehole with water for any previous measurement. General clean up and maintenance of the area. Monitor

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spectral integrity by copying spectral files from logging computer disk to data management computer disk and using appropriate programs.

3.5 SPECIAL CONDITIONS

If any model has the initial water level below the top barren zone, then, notify the model custodian on that day.

If a second day is required to complete the data collection, then, the last model of the previous data collection day must be first measured, but only three (3) sample spectra are required before moving to the next model in the calibration sequence. Likewise the verification process must be performed at the start and end of each day.

If instrument fails at end-of-the day FWHM test during verification, then, notify geophysics leader on that day.

If the instrument fails during a calibration data collection event, then, after repair the instrument is given a new configuration ID and the entire calibration data collection must be performed. That is the first few model data sets cannot be used for the new instrument configuration, even if the data are acceptable.

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ATTACHMENT F. LOG SURVEY VERIFICATION PROGRAM FOR HPGe SPECTRAL GAMMA-RAY DETECTORS (FVERFY).

1.0 OBJECTIVE

The FVERFY program locates the field verifier reference peak (583 KeV) in an HPGe spectra file, computes the net count rate, FWHM, and the gross spectra count rate. The results are reported to the logging technician for the pre-survey and post-survey spectra files. The field verification measurements are added to a historical file (C:\FVERFY.DAT). The program operation is automatic with no input parameter from the operator.

2.0 PROGRAM SETUP

The executable program (FVERFY.EXE) should be added to the C:\PROGRAM directory of the log analysis computer of the logging truck to permit access via the operating system PATH command. No batch file is necessary.

3.0 FVERFY OPERATING INSTRUCTIONS

FVERFY is intended to be executed from the current disk directory that contains the -.CHN spectral files to be processed (i.e. File Manager or Windows Explorer). The program execution is automatic, requiring no operator input, and has two main program options. The two 2 main options of FVERFY are:

- Automatic option for **Normal Field** use in which the pre-survey or (pre- and post-survey) spectra files are present on the current disk directory.
- **Electronics Engineer Option** permits a single spectra file to be processed (file name normally supplied on the run string.) FVERFY is used to measure the FWHM of the detector after repairs are complete before returning to field logging operation. The FWHM reference value (created here) must be added to the appropriate "PROBE" record in the EFFIC.FIL file as the 8th parameter.

There are other actions the program performs and they are discussed in Attachment G.

The field verification results are added (appended) to the historical results file (C:\FVERFY.DAT) when all four field verifier spectra files are processed (i.e. -CAB, -BAB, -CAA, and -BAA). The historical file is automatically created if not present.

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4.0 AUTOMATIC EXECUTION OPTIONS

If the FVERFY program is executed with no file name supplied in the run string then it examines the *.CHN spectra files of the current disk directory to determine if the Normal Field option or Electronics Engineer option is to be set.

FVERVY selects the <u>Normal Field option</u> if the current disk directory contains field verify files (i.e., [-CAA.CHN and -CAB.CHN] or -CAB.CHN.) If the field verify files are present then one of five possible execute paths is selected. The presence of survey data files (-000.CHN through -999.CHN) will not impact the program operation. The possible execution paths are:

A. If more than one set of the -CAB,-BAB,-CAA,-BAA files are present on the current disk working directory an error message will be given and program execution will terminate. The error message will indicate that multiple sets of the pre- and post-verifier CHN files must not be present on working directory. In order to successfully execute FVERFY, the operator must move the four field verify files to a separate working directory before re-executing the program.

B. The pre-survey survey files are present (i.e., -CAB.CHN and -BAB.CHN) on the current disk directory, but the post-survey verify files are not present (i.e., -CAA.CHN and -BAA.CHN.)

C. Only the pre-survey calibration file (i.e., -CAB.CHN) is present, the background file (i.e., -BAB.CHN) is missing. FVERFY locates the reference gamma-ray peak (583 KeV), computes the net peak count rate, FWHM, and gross spectra count rate. The results are reported to the analyst with the message that no background spectra was collected and that the verify function is <u>INCOMPLETE</u>.

D. Both sets of pre- and post- field survey files are present (i.e., -CAB, -BAB, -CAA, and -BAA). This is the option in which the program will compute all values for the historical file and add the record to the end of C:\FVERFY.DAT. The values in the record (16 data values described in Attachment A) are separated by comma and can be loaded into a graphing program, data base, or spread sheet for further examination.

E. If at least one of the four required files is missing the program gives an error message and terminates without performing the requested calculations. In order to successfully execute FVERFY, the operator must add the missing field verify file(s) to the disk directory before starting the program.

The detail steps of each program execution path are given in Attachment G.

The <u>Electronics Engineer option</u> is selected if one of the following conditions are met. The option is used to evaluate the FWHM of a single (583 KeV) peak in a -.CHN spectra file. This program option is activated by one of three ways.

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X. The name of a CHN file is provided on the run string when the program is executed.

Y. There is only one CHN file present in the working directory where the program is executed.

Z. There are multiple CHN files on the current working directory but none are identified as field survey verify files (i.e., -CAA, -CAB, -BAA, or -BAB). The program list the last 15 files (chronological order in the directory list) on the screen, sets the default to the last file, and asks the operator to enter the file name if different than the default.

The suggested name of the CHN spectra files for validating tool repairs should contain (in the first 8 characters) information on: Probe ID, Truck, Verifier Source ID, and Date or sequence number. One possible approach is a file name that looks like: B31A9803.CHN,

where:	B	=	Truck code (A=RLS-1, B=RLS-2, etc)
	31	=	Variable characters in gamma probe ID: RLSG3.1
	A	=	Verifier Source code (A=Coleman-1, B=Coleman-2, etc)
	98	=	Year (1998, when 2000 then enter as 00)
	03	=	Month (03=March); or enter sequence number within the year, either should be OK but must be consistent.

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ATTACHMENT G. FVERFY PROGRAM STEPS.

The FVERFY program steps for each automatic option are detailed below.

1.0 ELECTRONICS ENGINEER OPTION PROGRAM STEPS

1. Read the CHN file, get probe ID, channel-to-energy calibration coefficients, field verifier source ID, Truck ID.

2. Locate the 583 KeV gamma peak to be processed. The spectra energy calibration must be within 5 KeV. If the 5 KeV limit is not met then the spectra energy calibration must be repeated. If another higher intensity peak is present within 50 KeV the program displays an error message and terminates execution.

3. Compute the net peak count rate [Compton background subtracted using live time (LT)], FWHM, and gross spectra count rate (using LT).

4. Display the spectra identification information and computed values on the screen. Build an ASCII text file of the same information that can be printed. The ASCII file name is the first 8 characters of the CHN file with -.FW2 extension. The file is written to the current working directory.

2.0 NORMAL FIELD OPTION PROGRAM STEPS

When the FVERFY has field verifier calibration files (-CA-.CHN) then its actions are automatic.

1. Read the -CAB.CHN file, get the probe ID, channel-to-energy calibration coefficients, and survey date. Open the EFFIC.FIL (in \PROGRAM directory), locate the appropriate PROBE record and extracts the FWHM value (8^{th} parameter on the PROBE record, called Reference Standard below). If the probe ID does not match then reset program execution path to "C" and give message to operator but continue.

The program actions then change depending on which -CA-.CHN files are present. Refer to the five program paths given above.

A. Too many field verifier files present. Write error message and abort.

B. Only pre-survey files (-CAB.CHN & -BAB.CHN) are present:

<u>The following steps will be referenced as "PROCESS" and will be called out later in "D"</u>

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1. Locate the 583 KeV gamma peak. The spectra energy calibration must be within 5 KeV. If another higher intensity peak is present within 50 KeV the program displays an error message and terminates execution.

2. Compute the net peak count rate, [1] FWHM, [2] Gross spectra count rate using LT.

3. Read the -BAB.CHN file (or appropriate -BA-.CHN file), locate the 583 KeV peak, compute the net peak count rate,

4. [3] compute Gross spectra count rate using LT,

5. Compute verifier source contribution by subtracting background from the verifier source values listed below:

   - [4] compute Delta Gross count rate (i.e., CAB_Gross minus BAB_Gross)

   - [5] compute Delta 583 KeV peak count rate (i.e., CAB_net583 minus BAB_net583)

End of "PROCESS" steps

1. Compare FWHM of CAB spectra with the reference standard.

2. [6] Display FWHM Pass/Fail statement. (Pass if FWHM < 1.5*FWHM_of_RefStd)

3. Report to the operator the 6 above values identified in square brackets [#].

C. Only the -CAB.CHN file is present:

1. Locate the 583 KeV gamma peak. The spectra energy calibration must be within 5 KeV. If another higher intensity peak is present within 50 KeV the program displays an error message and terminates execution.

2. Compute the net peak count rate, [1] FWHM, [2] Gross spectra count rate.

3. Compare FWHM with the reference standard. (If probe ID did not match then set FWHM ref std to 0.0 KeV which will always FAIL.)

4. [3] FWHM Pass/Fail statement. (Pass if FWHM < 1.5*FWHM_of_RefStd)

5. Report to operator the 3 bracket values [#]

D. All 4 field verify files present (i.e., -CAB, -BAB, -CAA, and -BAA):

1. Read the -CAA.CHN file.

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Perform the "PROCESS" defined in A. above

2. Compare FWHM with the reference standard.

3. [6] FWHM Pass/Fail statement. (Pass if FWHM < 1.5*FWHM_of_RefStd)

4. Report to operator the 6 bracket values [#]

5. Read the -CAB.CHN file.

Perform the "PROCESS" defined in A. above

Build 16 value comma delimited record; add at end of C:\FVERFY.DAT:
1 - Survey date (yy/mm/dd)
2 - Survey date as fractional year (yy.yyy) for graphics display
3 - Truck ID from -CAB.CHN file
4 - Field verifier ID
5 - Probe ID
6 - FWHM Reference Standard from the EFFIC.FIL file
7-11 (computed values from the pre-survey spectra files)
7 - Gross spectra count rate from the -CA-.CHN file
8 - Gross spectra count rate form the -BA-.CHN file
9 - Delta Gross (CAlib - BAckground) count rate
10- Delta 583 KeV peak count rate
11- FWHM of 583 KeV (in KeV)
12-16 (same set of 5 values for the post-survey spectra files)

E. At least one field verify file is missing. Write error message and stop program.

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ATTACHMENT H. DIRECTIONAL GAMMA-RAY LOGGING.

1.0 APPLICABILITY

This attachment describes the minimum technical requirements for borehole directional gamma-ray survey logging to be performed by WMNW. Directional Gamma-ray logging is conducted at discrete depths of interest and may be used to identify the radial position of point source gamma-ray emitting radionuclides. The depth locations of interest shall be determined by passive gamma-ray logging.

Instrument field verification and operation instructions presented, conform as much as possible to the *Recommended Practice for Standard Calibration and Format for Nuclear Logs* (API 1974), as well as accepted uranium industry standards for spectral gamma-ray logging, *Borehole Logging for Uranium Exploration* (IAEA 1982).

2.0 DEFINITIONS

2.1 EQUIPMENT

Surface and subsurface equipment that operates a borehole detector under conditions of calibration supported configuration as defined on the geophysical logging system configuration.

2.2 PERSONNEL RESPONSIBILITIES

The logging geophysicist, or a logging technician, operates the logging equipment, ensures that the log data are properly recorded in an interim storage device, and ensures that the log data are transferred to a permanent mass-storage medium.

3.0 PROCEDURES

3.1 PREPARATIONS FOR LOGGING

3.1.1 Safety

1. All geophysical logging conducted at active characterization or well construction sites shall comply with applicable site safety plans (e.g., HASPs, HWOPs, etc.) and RWPs.

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2. Logging conducted at remote work sites shall be conducted in compliance with the controls outlined in the Job Hazard Analysis specific for site-wide geophysical logging.

3. Safety equipment may include steel-toed shoes/boots, hard hat, blue coveralls, leather gloves, eye and hearing protection, and two-way communication.

   a. Anti-contamination clothing may be required as directed by the RWP regulating the work site, or by the RWP specific to geophysical logging.

   b. Capped wells in known organic vapor/liquid contaminated areas must be surveyed with an organic vapor monitor (OVM) before being entered.

3.1.2 Borehole Survey Data Documentation

Use the Directional Survey Data Sheet (Figure H-1) to record pertinent information for each survey conducted in a borehole.

3.1.3 Completing the Borehole Survey Data Sheet

1. If a particular data field is not applicable to a particular logging session, indicate by entering N/A in that field.

2. Make all log data entries with permanent black ink.

3. Line out corrections with a single line and place the correct entry as close as possible to the incorrect one. Initial and date the correction.

4. The Directional Survey Data Sheet shall be signed and dated by the individual entering the information.

3.1.4 Calibration

A base calibration of the directional probe is performed at the time of the equipment assembly and when system components are subjected to major repairs or alterations that change performance characteristics.

This tool is operated as a gross gamma directional detector. Calibration of the directional accuracy of the device will be verified by the following means:

1. A known button source(s) will be placed at uniform distance adjacent to the upright probe. At radial positions around the probe directional window. Detector responses will be recorded at numerous radial positions to establish angular field of view of the detector.

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2. A known button source will be placed adjacent to upright casing. Location will be recorded in logbook.

3. The directional control equipment will be placed on the casing.

4. The operational tool operated and verified per the following procedure will be rotated through 360° gathering total count data.

5. The graphic display of the gathered data will be compared to the mapped location of the source. Agreement of mapped versus derived data will constitute operational verification.

3.1.5 Elevation Datum

Tool reference zero shall coincide with the reference used for the spectral gamma-ray log survey. Additionally,

1. Casing specifications shall be verified with previous spectral gamma log survey, record differences on the Directional Survey Data Sheet. At active sites, where ground surface is estimated and/or borehole installation is recent, the casing stickup shall be recorded.

2. If water is present in the borehole, the level will be determined from top of casing and recorded on the Directional Survey Data Sheet. The directional survey probe shall not go below top of water level.

3.2 FIELD OPERATIONS

3.2.1 Prerequisites

Boreholes drilled, or existing, in areas where radioactive contaminants are known or suspected to exist in the subsurface shall be checked by swab test prior to logging. The swab shall be surveyed for radioactive contaminants by an RCT.

3.2.2 Equipment Setup

1. Position logging truck to access well with logging tool.

2. Swing logging cable suspension boom to rear of truck.

3. Connect logging cable to logging tool.

4. Place logging cable over boom sheave wheel.

5. Suspend logging tool via cable over sheave wheel.

6. Turn power on to instrument.

3.2.3 Program Startup

1. Start computer logging control program per CASSAS procedures manual

2. Enter required information to access "initialization and calibration" screen.

3.2.4 Prelogging Energy Calibration

1. Attach field verifier to logging tool aligned with milled out viewing window on probe shield.

2. Collect energy-calibration spectra, record gross count rate on Directional Survey Data Sheet.

3. Execute energy-calibration sequence per CASSAS procedures manual.

4. Reposition field verification source to opposite milled out window on probe shield (180 degrees away from milled out window.)

5. Perform a background data collection and record this gross on Directional Survey Data Sheet.

6. Measure the FWHM of the 583 keV photo peak using FVERFY program (Attachment F).

7. If FWHM is higher than acceptance (Quality Control [QC] Acceptance Criteria) then allow tool to continue electronic warm up for 10 minutes and repeat test. If this second value of FWHM is also larger than acceptable, then make adjustments to instrumentation gain settings and allow 10 minutes before taking a third measurement. If the third FWHM is also larger than acceptable, then, replace instrument with another and restart logging procedures; notify maintenance engineer of instrument failure.

8. Record successful FWHM value on directional survey data sheet.

3.2.5 Logging

1. Cover logging tool with plastic sleeve (as appropriate).

2. Attach logging tool centralizer when the inside diameter of the casing is greater than 4.5 inches.

3. Align well head directional fixture with casing reference mark and secure to well head.

4. Attach alignment tubing to top of logging probe, lower probe into borehole and secure tubing in wellhead directional fixture.

5. Position logging tool at "reference" position. (Center of primary detector is located at depth reference datum.)

6. Move probe to predefined depth location for directional measurement set.

7. Acquire stationary measurements at each of 8 locations (points around the compass) at times specified by Logging Engineer. Document measurements on Directional Survey Data Sheet. Do not twist probe cable beyond 180 degrees in well head fixture.

8. Review results, identify locations for intermediate measurement directions.

9. Advance the probe to the next predefined depth location for directional measurement set and repeat from steps 7.

10. Return probe to surface, removing alignment tubes as required and removing well set directional measurement fixture. Verify well head fixture retained orientation with casing reference mark.

11. Have cable, tool sleeving, and tool surveyed for radioactivity upon completion of logging in each borehole, unless previous arrangements have been made with an RCT.

3.2.6 Postlogging Performance Verification

Shall be conducted as described in Section 3.2.4 (Energy calibration in 3.2.4.3 is optional). Any deviations between the pre- and post- calibrations shall be recorded on the Directional Survey Data Sheet. If logging operations will continue on adjacent borehole without turning off equipment power, then post logging performance verification is optional.

3.2.7 Equipment Takedown

1. Exit computer logging program.

2. Transfer the recorded electronic file to the WMNW data storage files per "Data Storage and Security for Raw Log Survey Data" (Attachment C).

3. Turn power off to instrument.

4. Place logging tool onto the tool rack in truck, disconnect from the cable, and secure.

5. Remove logging cable from boom sheave wheel.

6. Move boom forward to traveling position.

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3.2.8 Logging Activities Conducted Within Surface Contaminated Areas

Movement of logging equipment into and out of contaminated areas (CAs) will be regulated in accordance with guidelines established for vehicle surveys from CAs. Special instructions pertaining to logging activities in contamination areas (e.g., dosimetry, personal protective equipment) are outlined in the RWP regulating geophysical borehole/well logging.

3.2.9 Records Disposition

When logging is completed, check the Directional Survey Data Sheet to ensure that:

1. All information is entered, legible and correct.
2. Abnormalities, observations, and adjustments are recorded in the "Notes" section.
3. Name, signature and date are recorded.

The logging geophysicist processes the logging documentation sheets as specified in Section 6.0 (Records) of this procedure. A copy of the data acquired and processed will be made on a removable disk. The data will be retained in Geophysics' Investigations' files. The files will be secured (locked), will be under fire protection conditions, and will have controlled access. Data files will be processed as described in Section 6.0 of this procedure.

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DIRECTIONAL SURVEY DATA SHEET

Project:	Well Name:	Well ID:
Date:	Location:	
File Name Prefix:	Logger:	LOGGING OPERATIONS PERFORMED PER PROCEDURES 17.0 GEOPHYSICAL LOGGING, WASTE MANAGEMENT – NORTHWEST Signature: Date:
Pre Log Verification: Gross ________ c/s Background ________ c/s Post Log Verification: Gross ________ c/s Background ________ c/s		

DIRECTIONAL SURVEY DEPTH: [ ] ft

Position	0°	45°	90°	135°	180°	225°	270°	315°				
File #												
Gross c/s												
LT (sec)												

DIRECTIONAL SURVEY DEPTH: [ ] ft

Position	0°	45°	90°	135°	180°	225°	270°	315°				
File #												
Gross c/s												
LT (sec)												

DIRECTIONAL SURVEY DEPTH: [ ] ft

Position	0°	45°	90°	135°	180°	225°	270°	315°				
File #												
Gross c/s												
LT (sec)												

DIRECTIONAL SURVEY DEPTH: [ ] ft

Position	0°	45°	90°	135°	180°	225°	270°	315°				
File #												
Gross c/s												
LT (sec)												

DIRECTIONAL SURVEY DEPTH: [ ] ft

Position	0°	45°	90°	135°	180°	225°	270°	315°				
File #												
Gross c/s												
LT (sec)												

DIRECTIONAL SURVEY DEPTH: [ ] ft

Position	0°	45°	90°	135°	180°	225°	270°	315°				
File #												
Gross c/s												
LT (sec)												

Directional_Survey_Form.doc

Figure H-1

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TITLE:

Neutron Capture Logging

Approved

J.J.Dorian, Program Manager
Environmental monitoring & Investigations

1.0 PURPOSE

This logging procedure provides guidelines and minimum requirements for neutron capture borehole logging. This operation includes collecting data for radioactive and non-radioactive waste detection and assessments, radioactive waste storage tank monitoring, environmental investigations, and site characterizations.

This procedure specifies personnel qualifications, personnel responsibilities, and general and specific methods that will be used to obtain geophysical log data, by Waste Management Federal Services, Inc., Northwest Operations (WMNW) workers or by subcontractors.

2.0 LIST OF TERMS AND DEFINITIONS

ac	alternating current
cm	centimeter
DOT	U.S. Department of Transportation
ft	foot
ft/min	feet per minute
RCT	radiological control technician
Hz	hertz
in.	inch
kg	kilogram
kPa	kilopascal
lb	pound
m	meter
m/min	meters per minute
psi	pounds per square inch
PTO	POWER-TAKE-OFF (switch)
rpm	revolutions per minute
RWP	Radiation Work Permit
V	volt
WMNW	Waste Management Federal Services, Inc., Northwest Operations
MOU	Memorandum of Understanding
Borehole	Any engineered construction or other access utilized to gather data with the geophysical tools and process described as taking place in a borehole. This includes, but is not limited to boreholes, wells, probe holes, pits, trenches, tanks, etc.

☒ A WORK MAY PROCEED SUBJECT TO INCORPORATION OF COMMENTS
☐ B REVISE AND RESUBMIT WORK MAY PROCEED SUBJECT TO INCORPORATION OF CHANGES INDICATED
☐ C REVISE AND RESUBMIT WORK MAY NOT PROCEED
☐ D REVIEW NOT REQUIRED WORK MAY PROCEED
CONTRACT NO. S-C95-17583-IC4
BY: [signature]
DATE: 4-7-99

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3.0 RESPONSIBILITIES

3.1 PROJECT MANAGER

The project manager performs the following:

- Designates the storage location for each logbook (maintained in appropriate logging truck).
- Ensures that the logbook is protected against damage, loss, and unauthorized changes.
- Determines priorities and schedules.
- Approves reports and other technical products before they are released to the customer.

3.2 PROJECT TECHNICAL LEAD

The project technical lead performs the following:

- Coordinates all data acquisition, data interpretation, and reporting for a particular project.
- Determines the priorities for data acquisition. Reviews the priorities with the customer, logging engineers, and other field workers to ensure that they establish and achieve realistic goals.
- Revises procedures. Along with the project manager, monitors the effectiveness of this logging procedure and reviews and approves revisions. Temporary revisions may be entered with pen and ink for a stated time or until the procedure is revised with the appropriate approval.
- Provides boom operation training and certification for the logging engineer, geophysicist, and technician.
- Approves work products.

3.3 LOGGING ENGINEER OR LOGGING GEOPHYSICIST

The logging engineer or Logging Geophysicist performs the following:

- Ensures that the project logging equipment is calibrated, reviews schedules for logging activities, and works with the technical lead to ensure that Site- or project-specific methods, such as counting times and depth increments, are understood and implemented. Ensures that routine maintenance of the logging unit is performed before operation.

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- Verifies the identity and features (depth, zero-depth reference, and casing configuration) of each borehole to be logged.
- Performs data acquisition.
- Performs or supervises the pre-survey field verification check, the borehole survey, and the post-survey field verification check for each borehole survey. Exceptions may be granted as specified by the Logging Geophysicist based on specific project goals.
- Documents (or supervises the documentation of) field logging operations by completing Borehole Survey Data Sheets (see example in Attachment) and maintaining a Borehole Survey Data Journal folder with sheets completed consisting of the collection of Borehole Survey Data Sheets for turnover for at project completion.
- Delivers log records to the customer.

3.4 LOGGING TECHNICIAN

The logging technician performs the following:

- Verifies the identity and features (depth, zero-depth reference, and casing configuration) of each borehole to be logged.
- Performs the pre-survey field verification check, the borehole survey, and the post-survey field verification check.
- Performs data acquisition.
- Documents field logging operations by completing Borehole Survey Data Sheets (see Attachment) and maintains the logging unit Logbook consisting of the chronological list of calibrations, borehole surveys, and equipment repairs.

4.0 REQUIREMENTS

4.1 PERSONNEL QUALIFICATIONS

4.1.1 Logging Engineer or Logging Geophysicist

The logging engineer or Logging Geophysicist must meet the following requirements:

- Hold a bachelors' degree with a major in geophysics, engineering, or a physical science with courses selected from geology, hydrology, physics, chemistry, applied mathematics, and engineering

- Have two or more years of applicable professional experience or hold an advanced degree in an appropriate technical discipline.

- Have completed one undergraduate course in applied nuclear physics or the equivalent of nuclear logging education and professional experience.

- Have passed all required training, including DOE Radiation Worker II training, and be willing to use radioactive sources.

- Have the ability to operate hydraulic boom control and draw-works.

- Possess knowledge of the following:

  - The particular logging methods used, including calibration methods and Borehole environmental correction methods

  - Use of the specific instrumentation used for neutron capture logging, including windows based personal computer

  - General features of nuclear logging equipment, including radiation detector physics, radiation detector types, detector energy resolution, electronic circuitry, and recording methods

  - Basic log interpretation principles.

The project manager may approve waivers or substitutions to particular items in the above list. A record of this action, accompanied by the justification and the name of the individual for whom the waiver or substitution applies, must be properly documented in the project records.

4.1.2 Logging Technician

The logging technician must meet the following requirements:

- Hold a two-year degree, or higher, in a technical field.

- Have passed all required training, including DOE Radiation Worker II training, and be willing to use sources.

- Hold a Class B driver's license.

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- Have the strength and dexterity to handle field equipment (logging cable, shields, collimators, and logging tools up to 29.5 kg [65 lb]).
- Possess basic knowledge in gamma ray detection physics.
- Possess basic skills with hand tools used in logging operations, including pliers, wrenches, socket wrenches, screwdrivers, and nut drivers
- Possess basic skills in computer operations.
- Have the ability to operate hydraulic boom control and draw-works.
- Have the ability to understand basic functions of logging truck components, including depth encoder, boom control, draw-works, nitrogen monitor, and truck engine monitors.

The project manager may approve waivers or substitutions to particular items (other than Radiation Worker II Training) in the above list. A record of this action, accompanied by the justification and the name of the individual for whom the waiver or substitution applies, must be properly documented in the project records.

4.2 HEALTH AND SAFETY REQUIREMENTS

All borehole geophysical logging operations, including subcontracted work, will comply with applicable health and safety plans, procedures, and regulations; RWPs; contractor safety plans; and Job Hazard Analysis.

4.3 QUALITY ASSURANCE REQUIREMENTS

All borehole geophysical logging operations, including subcontracted work, will comply with applicable quality assurance plans, procedures, and regulations.

The customer documents define quality assurance requirements and implementing requirements consistent with WMNW *Quality Assurance Program Project Plan for Borehole Geophysical Logging* (ES-QAPjP-001, Rev. 0).

4.4 RECORDS MANAGEMENT REQUIREMENTS

All borehole geophysical logging operations, including subcontracted work, will comply with applicable records management plans, procedures, and customer requirements.

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5.0 PROCEDURE

5.1 WMNW LOGGING OPERATIONS

5.1.1 Preparations

The driver of the logging truck will perform a vehicle inspection at least once per day before truck movement. If the truck is to be moved onto a public highway, this inspection will comply with all U.S. Department of Transportation (DOT) requirements and will be documented as per DOT regulations (49 CFR, "Transportation"). Personnel driving the logging trucks on public roads are required to have a valid Class B Commercial Drivers License.

Before deployment of the logging operation, the logging engineer/technician will ensure that the instruments and mechanical systems are operational and the energy calibration current.

Truck movement will be on an established road unless access to a borehole requires off-road driving.

After arriving at the borehole, the logging engineer will verify the borehole identity and the pertinent features, including depth, zero-depth reference, casing configuration, and contaminant-bearing depth intervals (if known).

5.1.2 Logging

The logging engineer/technician will record all pertinent information on a Borehole Survey Data Sheet as follows:

1. Indelible black ink will be used for handwritten entries.

2. If a particular data field is *not applicable*, enter "N/A" in the space for that field.

3. Line out incorrect information with a single line and write the correct entry next to the incorrect one. Initial and date the correction. Do not use correction fluid, erasers, or highlighter pens to make corrections.

5.1.2.1 Logging Truck Start-up Procedure.

1. After the logging unit is in position to log the borehole, apply the **parking brake** and place one set of **wheel chocks**.

2. Connect the hydraulic generator power cable to the main plug at the alternating current (ac) input panel and turn **ON** the main circuit breaker. This step is only necessary if the logging unit has been connected to external power and will be switched to generator power.

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3. Go to the front driver cabin and put the gearshift lever in neutral, turn **OFF** the POWER-TAKE-OFF (PTO) switch (right-hand position), and put the transfer case switch to neutral (middle position).

4. Turn the engine **ON** from the front driver cabin and wait until the air-tank gauge indicates more than 620.5 kPa (90 psi) and the low air pressure warning alarm turns **OFF**. The transfer case and PTO winches operate by air pressure and will not activate unless there is adequate air pressure.

5. While depressing the clutch, put the truck in sixth gear and turn **ON** the PTO switch (left-hand position). The red PTO light illuminates when the switch is ON.

6. SLOWLY release the clutch to engage the PTO. The red LED light illuminates on the CONSOLE when the PTO is engaged.

5.1.2.2 Logging Truck Power-Up/Power-Down Sequence for the Instrument System.

1. Make sure all circuit breakers and individual power switches are in the **OFF** position at the beginning of this sequence.

2. Turn **ON** SENSOR and CONSOLE circuit breakers on the right-hand (direct current) side of the breaker panel. The CONSOLE instrument gauges and the red direct-current light on the SENSOR PANEL energize. **Make sure the winch is not turning at this point by pushing down the EMERGENCY STOP button on the console.** When the EMERGENCY STOP button is engaged, the red brake light above it illuminates.

3. Bring the engine revolutions per minute (rpm) up to approximately 1,100 rpm by turning the THROTTLE on the CONSOLE counterclockwise. Check the generator voltmeter and frequency-meter at the power distribution panel. Adjust the THROTTLE until the meters indicate 120 V ac and 60 Hz.

4. Turn **ON** COMPUTER, WALL 1, ac, and WALL 2 circuit breakers on the left-hand (ac) side of the breaker panel.

5. Turn **ON** the UNINTERRUPTIBLE POWER SUPPLY (top button for on, bottom button for off), hold for 1 second; in sequence, turn **ON** the NIM BIN POWER SUPPLY, REMOVABLE DISK DRIVE, COMPUTER MONITOR, and, lastly, the COMPUTER CENTRAL PROCESSING UNIT if required. The electronic system should warm up approximately 10 minutes before data collection.

   NOTE: The computer may not boot properly unless the NIM BIN is turned ON before the COMPUTER CENTRAL PROCESSING UNIT.

When shutting the instrument system down, the sequence should be reversed.

5.1.2.3 NIM BIN Power Supply.

1. Before connecting or disconnecting the cable head to the sonde, switch **OFF** the NIM BIN power supply. Connecting or disconnecting the cable head and the sonde with the NIM BIN power **ON** could cause an electronic failure in the tool.

2. Connect logging cable head to sonde per section 4.1.2.7.

3. Turn the NIM BIN power ON after the sonde has been connected. By following this sequence, the computer need not be restarted.

5.1.2.4 Logging Truck Crane Control.

Only authorized personnel may maneuver and operate the crane.

1. Set the outrigger pads and deploy the outriggers to stabilize the crane.

2. Do not attempt to completely unload the vehicle suspension.

The crane and winch may be operated either from the REMOTE PENDANT or from the CONSOLE (hoist) and HYDRAULIC CONTROLS at the base of the crane.

5.1.2.5 Remote Pendant Crane Operation.

1. Set the HOIST switch on the CONSOLE to MANUAL and check that the red REMOTE LED is lit.

2. Release the EMERGENCY STOP button by twisting clockwise.

3. To select the REMOTE PENDANT for crane operation, go to the back of the truck and switch the HYDRAULIC CONTROL lever at the base of the crane to the left-hand position. **Make sure there are no overhead power lines within 10 feet or other nearby overhead equipment that could contact or come near the crane.**

5.1.2.6 Manual Control Crane Operation.

1. Set the HOIST switch on the CONSOLE to MANUAL and check that the red REMOTE LED is lit. Leave the EMERGENCY STOP button **ON**, locking the winch.

2. To select MANUAL CONTROL crane operation, go to the back of the truck and switch the HYDRAULIC CONTROL lever at the base of the crane to the right-hand position. **Make sure there are no overhead power lines within 10 feet or other nearby overhead equipment that could contact or come near the crane.**

3. Bring the crane out of the resting position, then connect the sheave-measuring wheel or optional auxiliary sheave wheel if remote logging configuration. The measuring wheel

should be positioned so the encoder box (cable connections) is facing the driver side of the vehicle. If remote logging configurations require, sheave-measuring wheel may be attached to well head fixture.

4. Connect the encoder cable to the encoder box. Connecting this cable to the box may create a weight overload signal to the sensor box. If this condition happens, the red EMERGENCY STOP LED on the CONSOLE turns **ON**, and control of the winch is locked out. To reset this lockout condition, cycle the EMERGENCY STOP button on the CONSOLE **ON** and **OFF** twice.

5. Roll out the logging cable using the remote pendant or the hoist control handle on the console.

6. Put the cable through the sheave wheel(s) (the potentiometer controls the roll out speed and is located on the bottom of the auto-fill junction box near the tool rack).

7. Position the cable head/sonde above the well using the crane. If remote logging configuration is required, use auxiliary well head fixture or remote crane to suspend sheave wheel.

8. Hook the two support legs on the end of the crane to stabilize it when logging. Optional if remote logging configuration is used.

5.1.2.7 Logging Tool.

1. Remove the logging tool from the truck's tool rack. Make sure the NIM BIN power is **OFF**. Position a centralizer on the sonde when logging boreholes greater than 12.7 cm (5 in).

2. Connect the neutron capture-logging tool to the cable head carefully. (Note: Neutron source is not installed in the tool at this time.) Simultaneously position the alignment pin on the probe with the notch on the cable head body and join the 22 pin step-up/step-down connector together.

4. Tighten the cable head. Be very careful not to nick or cut the O-ring on the probe. If the O-ring is damaged or worn, replace it with a new one and lightly grease it.

5. Turn the NIM BIN power **ON.** Allow instrument to stabilize for approximately 20 minutes before data collection.

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5.1.2.8 Computer Automated Spectral Acquisition System II (CASASII) Logging Setup.

1. The CASASII program may be started from the Windows "Log Program" icon. The program then displays the 12 CASASII Main Menu commands. The 12 main menu commands are started using the keyboard function keys F1 through F12. Pressing <ESC> returns the user to the main menu. See the CASASII User Manual (Greenspan 1994) for additional information.

2. Execute FILE/DIRECTORY COMMANDS (F6) from the main menu, and select SET DEFAULT DATA DIRECTORY (F1 on the directory screen) or MAKE DATA DIRECTORY (F3 on the directory screen). SET DEFAULT DIRECTORY allows the user to set the default data directory to any directory that already exists. MAKE DATA DIRECTORY allows the user to create a new data directory. All data directories have the ".DIR" extensions. Setting this directory at startup is important.

3. Enter the DIRECTORY name to correspond to file name prefix from Logbook. Execute the LOAD INITIALIZATION DEFAULTS (F8) command and respond by entering "CFTool".ini. This will load the correct 921 module settings.

   NOTE: The Ortec multichannel analyzer program called "M2SETUP" must have been executed to 8K channels and the multichannel analyzer program must have been run before this will work.

   Execute LOG INITIALIZATION (F1) from the main menu and enter the well identification, well location, experimenter, filename header, and other logging information.

4. Each spectrum will be named with an eight-character label. The filename header is the first through fifth characters and must be entered by the logging engineer or the logging technician. The logging software will determine the sixth through eighth characters and attach the ".CHN" extension.

5.1.2.9 Detector Presurvey Passive Field Verification.

1. Attach field verifier to logging tool at preselected location. Field verifier emits gamma-rays with no neutron emissions.

2. Collect energy-calibration spectra (300 sec.).

3. Execute energy-calibration sequence per CASSAS procedures manual.

4. Measure the FWHM of the 583 keV photo peak using FVERFY program (Attachment F).

5. If FWHM is higher than acceptance (Quality Control [QC] Acceptance Criteria) then allow tool to continue electronic warm up for 10 minutes and repeat test. If this second value of FWHM is also larger than acceptable, then make adjustments to instrumentation gain settings and allow

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10 minutes before taking a third measurement. If the third FWHM is also larger than acceptable, then, replace instrument with another and restart logging procedures; notify maintenance engineer of instrument failure.

6. Record gross count rate and successful FWHM value on survey data sheet.
7. Remove field verification source.
8. Perform a background data collection and record this gross on survey data sheet (300 sec.).

5.1.2.10 Setting the Initial Depth.

1. Before placing the source into the instrument, position the measure point reference mark on the instrument directly adjacent to the top of casing or ground level, whichever is the depth datum point defined by the customer. 2. Reset the depth counter on the console.
3. Execute DEPTH CONTROL (F3) on the main menu.
4. Use F2 to enter the well depth and tool position, which is from top of cable head to center reference of source/detector.

5.1.2.11 Neutron Source Installation/Removal

1. Remove neutron source in shipping shield from source storage compartment or designated source storage area and place it within easy reach of the well head.
2. Position and zero the logging tool in the well to be logged. Then pull the tool out of the well so it is approximately 3 feet above ground level.
3. Remove Cf^{252} source from source shipping shield, using source handling tool, install in source receptacle on logging tool and lightly tighten. Remove source-handling tool from source and immediately signal an assistant at the logging truck hoist lower the tool into the well to the top of the cable head and record depth registered on counter on the BSDS. The source handler shall have been trained on safe handling of the source per Safe Handling Procedure WMWN-CM-7-20.
4. Reverse steps for source removal.

5.1.2.12 Detector Presurvey Energy Calibration

1. Execute DETECTOR CALIBRATION (F2) from the main menu screen for energy calibration.
2. Select PRECAL (F7 on the calibration screen) and set up to acquire a spectrum for 300 seconds. Press F5 to begin the collection.

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3. The 2.2 Mev Hydrogen peak shown in the displayed spectrum should be located within the range of channels 1820 to 2220 of the 8K-channel spectrum.

4. Press F12 again to toggle the acquisition controls.

5. Select Cursor 1b, using F11, and move it onto the centroid of the Hydrogen 2.2 Mev peak using the cursor control keys. Note the channel indicated on the screen.

6. Adjust the fine gain on the 973 amp, as necessary, and press F10 to restart the acquisition.

7. Repeat this process until the 2.2 Mev Hydrogen is within the range of channels 1820 to 2220 of the 8K-channel spectrum. Typically the signal gain will stabilize near the end of the 10-minute warm-up period, so do not make these fine adjustments until the end of this period. When the peak has stopped drifting, let the system count for the full 300 seconds.

7. The spectrum will be displayed on the computer monitor. The logging engineer will verify that a full spectrum has been acquired and that the neutron spectrum has the expected shape.

8. Collect energy-calibration spectra (300 sec.).

9. Execute energy-calibration sequence per CASSAS procedures manual.

10. Measure the FWHM of the Fe Peak @ 7645 keV and the H Peak @ 2223 keV using FVERFY program (Section 17.0, Attachment F).

11. If FWHM is higher than acceptance (Quality Control [QC] Acceptance Criteria) then allow tool to continue electronic warm up for 10 minutes and repeat test. If this second value of FWHM is also larger than acceptable, then make adjustments to instrumentation gain settings and allow 10 minutes before taking a third measurement. If the third FWHM is also larger than acceptable, then, replace instrument with another and restart logging procedures; notify maintenance engineer of instrument failure.

12. Record gross count rate and successful FWHM value on survey data sheet.

13. After the PRESURVEY collection is complete, write the current spectrum to the default directory.

14. If the logging engineer's professional judgment indicates that the system is ready to log the borehole, then the logging engineer (or the logging technician, acting under the logging engineer's instructions) will fill out the appropriate spaces on the Borehole Survey Data Sheet.

5.1.2.13 Acquiring Spectra.

1. Execute ACQUIRE SPECTRA (F4) on the main menu. This function may only be invoked if LOG INITIALIZATION (F1), DETECTOR CALIBRATION (F2), and DEPTH

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CONTROL (F3) have been executed previously and are noted on the CASASII main menu screen by checkmarks beside their titles.

2. Select logging mode (F1), CONTINUOUS, (F2), MOVE-STOP-ACQUIRE, or (F3) COUNT.

3. Set the depth increment at 15 cm (0.5 ft).

4. Start the (software controlled) logging run (F5).

5.1.2.14 Logging Reruns.

Logging system should be tested with a rerun interval of 10% of survey interval for each borehole.(Exceptions may be granted by Logging Geophysicist based on specific project goals.)

Depth intervals that should be considered for reruns are intervals of moderate detector response, intervals that include overlaps of consecutive log runs, or intervals within which the gamma-ray intensity increases or decreases. The logging engineer/technician will select the interval and note the reason for the selection on the Borehole Survey Data Sheet.

Treat the rerun interval as a separate log interval and note it on the Borehole Survey Data Sheet as a logging rerun. Collect the rerun using the same data acquisition parameter normally set up for the logging operation.

5.1.2.15 Zero-Depth Reference Check.

1. Following completion of the logging run, the sonde will automatically return to the "0" reference point established in 5.1.2.10.

2. Manually return the cable head top to top of casing, and record +/- difference (if any) on the BSDS.

3. Perform detector post-energy calibration per 5.1.2.12 if the logging activities have been completed. Post survey performance verification is optional if logging tool will be moved to adjacent borehole with out turning off tool power. Remove the instrument from the borehole using the hoist and immediately return the source to the source shipping shield.

5.1.2.16 Detector Post-Survey Passive Detector Performance Verification.

At the end of each logging run or daily as applicable, the logging engineer/technician will obtain a post-survey verification. The post-survey performance verification is optional if logging tool will be moved to adjacent borehole without turning off tool power.

1. Attach field verifier to logging tool at preselected location. Field verifier emits gamma-rays with no neutron emissions.

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2. Collect energy-calibration spectra (300 sec.).

3. Execute energy-calibration sequence per CASSAS procedures manual.

4. Measure the FWHM of the 583 keV photo peak using FVERFY program (Attachment F).

5. If FWHM is higher than acceptance (Quality Control [QC] Acceptance Criteria) then allow tool to continue electronic warm up for 10 minutes and repeat test. If this second value of FWHM is also larger than acceptable, then make adjustments to instrumentation gain settings and allow 10 minutes before taking a third measurement. If the third FWHM is also larger than acceptable, then, replace instrument with another and restart logging procedures; notify maintenance engineer of instrument failure.

6. Record gross count rate and successful FWHM value on survey data sheet. Save as PostCal.

7. Remove field verification source.

8. Acquire post background survey spectrum for 300 seconds. Save file F6, save PostBak.

5.1.2.17 Equipment Rig Down.

1. Copy the data files from the hard drive to the removable disk following the directory hierarchy specified in the procedures manual.

2. Remove the source in the reverse order as described in section 4.1.2.7 of this procedure.

3. Turn **OFF** the NIM BIN power before separating the sonde for storage. Place the sonde in the tool rack

4. Remove the logging cable from the measuring sheave wheel; then remove the sheave wheel from the boom or well head fixture if remote logging configuration is used.

5. Retract the boom and outriggers and lock in the traveling position.

6. Complete the remaining items on the Borehole Survey Data Sheet.

7. Complete and sign the logbook entries for the day.

8. Secure loose items, stow portable stairs, and secure doors. Place unsecured items cabinets or secure by approved means before moving the logging truck.

9. Before exiting the control cabin at the end of the day, turn **OFF** the electrical system and disengage the PTO throttle. Lock the door after exiting. Tool power and control cabin power need not be turned off when moving truck to adjacent borehole for continued logging.

10. Walk around the truck before moving it.

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5.1.3 Decontamination

The RCTs will survey the logging cable and sonde as they emerge from the borehole and after the logging is finished. If radioactive contamination is detected, direction will be provided by the RCT. Decontamination will be performed under a separate RWP.

5.1.4 Records

The logging records consist of the following:

1. Logbook
2. Borehole Log Data Sheets
3. Log Survey data files.

5.1.4.1 General Requirements. Logbooks used for logging activities are numbered on the outside front cover, have horizontally ruled pages, and are sequentially numbered on each page.

5.1.4.2 Logbook Requirements. The truck logbook contains the following:

- Major equipment status (outages) changes
- Major system and equipment testing
- Data file sequence number
- Well data, depth, and water level
- Logging parameters, speed, and time or depth interval.

Record events as completely as possible, and communicate information as clearly as possible to maximize understanding by logbook readers.

5.1.4.3 Logbook Entry Requirements.

1. Make entries in black indelible ink.

2. Correct entries, if necessary, to ensure readability and accuracy. Do not erase the original entry or use correction fluid, tape, or other method of correction that will obliterate, obscure, or remove that entry. Make corrections by drawing a single line through the entry, inserting the correct information as closely as possible to the original entry, and initialing and dating the correction.

5.1.4.4 Neutron Capture Logging. Logging records consist of the completed Borehole Survey Data Sheets and the spectral data files.

The logging engineer will complete the Borehole Survey Data Sheets, when practical, after the logging run is finished.

5.1.4.5 Spectrum Data Files. These are recorded by software and must be zipped, stored, and backed up at the end of each logging run or daily on a second drive, removable disk, or floppy disk. This data file record is returned to the office for analysis and archiving.

6.0 REFERENCES

A-6002,027, Hanford Job Hazard Analysis Checklist.

49 CFR, "Transportation," *Code of Federal Regulations*, as amended.

Greenspan, 1994, *Computer Automated Spectral Acquisition System II (CASASII) User Manual*, Greenspan, Inc., Houston, Texas.

Meisner, J. E., R. K. Price, and R. R. Randall, 1996, Radionuclide Logging System In Situ Vadose Zone Moisture Calibration, WHC-SD-EN-TI-306, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

RL, 1996, *Hanford Radiological Control Manual*, DOE/RL-96-109, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

WMNW/MACTEC, 1998, *Quality Assurance Implementation Plan*, WMNW/MACTEC-MEIER-___, Rev. 0, Waste Management Federal Services, Inc., Northwest Operations, Richland, Washington.

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7.0 ATTACHMENT: BOREHOLE SURVEY DATA SHEET

BOREHOLE SURVEY DATA SHEET

Project:
Well Name:
Well ID:

Date:
Location:

Notes: ____________________

BOREHOLE LOGGING INFORMATION

Logger: ____________________ Logging Unit Configuration: ____________________

Depth Datum Reference: ____________________ Instrument Calibration Configuration: ____________________

Total Well Depth: ________ ft Source: ____________________ Water Level: ________ ft Source: ____________________

Source for Casing Parameters: ____________________

Casing Diameter: ________ in.	Wall Thickness: ________ in.	Type of metal: ________	Total Depth: ________ ft	Stickup: ________ ft
Diameter: ________ in.	Wall Thickness: ________ in.	Type of metal: ________	Total Depth: ________ ft	Stickup: ________ ft
Diameter: ________ in.	Wall Thickness: ________ in.	Type of metal: ________	Total Depth: ________ ft	Stickup: ________ ft
Diameter: ________ in.	Wall Thickness: ________ in.	Type of metal: ________	Total Depth: ________ ft	Stickup: ________ ft

File Name Prefix: ________ Field Disk/Part. ________ Return Error: ________ in. (High/Low) at ________ ft Field Verifier ID: ________

Pre Log Verification: Gross ________ c/s Background ________ c/s Th 583 keV photo peak FWHM ________

Post Log Verification: Gross ________ c/s Background ________ c/s Th 583 keV photo peak FWHM ________

Log Interval: Fix Speed	________ fpm	Move-Stop-Acquire ________ s (LT/RT)	LOGGING OPERATIONS WERE PERFORMED AND EQUIPMENT CLEANED AS PER PROCEDURES, 17.0 GEOPHYSICAL LOGGING WASTE MANAGEMENT - NORTHWEST
Depth Range: Start	________ ft	Stop ________ ft Incr ________ ft	
Log Interval: Fix Speed	________ fpm	Move-Stop-Acquire ________ s (LT/RT)	Prepared by (print) ________
Depth Range: Start	________ ft	Stop ________ ft Incr ________ ft	Signature:
Log Interval: Fix Speed	________ fpm	Move-Stop-Acquire ________ s (LT/RT)	
Depth Range: Start	________ ft	Stop ________ ft Incr ________ ft	
Log Interval: Fix Speed	________ fpm	Move-Stop-Acquire ________ s (LT/RT)	
Depth Range: Start	________ ft	Stop ________ ft Incr ________ ft	Date: ________

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TITLE:

Safe Operating and Storage for the Neutron Capture Measurement Probe Source

Approved By:

J. J. Dorian, Program Manager
Environmental Monitoring & Investigations

1.0 PURPOSE

This procedure establishes the radiation protection requirements for performing tests and measurements with an isotopic or chemical source neutron source as part of a Capture measurement sensor developed by Waste Management Federal Services, Inc., Northwest Operations (WMNW). The procedure governs the use of this neutron Capture measurement device.

2.0 SCOPE

The requirements of this procedure address personnel qualifications and responsibilities, facilities, dosimetry, equipment, equipment operation, and documentation during the use of the neutron Capture measurement device. These requirements are specified in accordance with HSRCM-1, Hanford Site Radiological Control Manual. This procedure is divided into two sections. The first, main section, applies to all applications and uses of the device, including testing and borehole logging. The appendices contain specific requirements for specific equipment or facility operation.

3.0 PERSONNEL RESPONSIBILITIES

3.1 RADIOLOGICAL CONTROL

For static neutron source testing and borehole logging operations, the Radiological Control (RADCON) organization is responsible for:

1. Reviewing and approving the safe operating and emergency procedures.
2. Developing Radiation Work Permits (RWP) for use of all radioactive source and generating devices.
3. Performing the necessary surveillance and appraisal of radiological operations and activities.
4. Providing personnel for sealed source integrity testing every six months.
5. Ensuring that all personnel present during the use of the device have the proper training

X A WORK MAY PROCEED SUBJECT TO INCORPORATION OF COMMENTS
☐ B REVISE AND RESUBMIT WORK MAY PROCEED SUBJECT TO INCORPORATION OF CHANGES INDICATED
☐ C REVISE AND RESUBMIT WORK MAY NOT PROCEED
☐ D REVIEW NOT REQUIRED WORK MAY PROCEED
CONTRACT NO. S-C95-175003-1164
BY:
DATE: 4-7-99

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and dosimetry, as required by the RWP.

6. Providing trained and qualified personnel to perform the required radiation and contamination surveys.

3.2 NEUTRON CAPTURE PROBE

The Neutron Capture probe operator (logging engineer or technician) is responsible for:

1. Writing and submitting safe operating for the neutron Capture measurement device for approval.

2. Assigning a source custodian.

3. Providing adequate training for personnel for the safe use and control of the radioactive sources and generating devices.

3.3 SOURCE CUSTODIAN

The Source Custodian must have current training as a source custodian as required by Department of Energy (DOE) policies. The required training for custodians of californium or americium neutron sources is documented in WMNW-IP-1019, "Material Control and Accountability Plan" and in WMNW-SD-QAPP-001, "Quality Assurance Program Plan for Source Control." Radiological worker training, as required by the RWP, is described in HSRCM-1, "Hanford Site Radiological Control Manual."

The source custodian is responsible for:

1. Ensuring that the neutron source(s) used with the neutron Capture probes are used and maintained in accordance with HSRCM-1.

2. Ensuring that the safe operating procedures and RWP are current and available during any use of the device.

3. Acting as the principle point of contact concerning source use, maintenance, or documentation.

4. Arranging for source shipments that meet the Department of Transportation (DOT) and WMNW shipping regulations.

5. Immediately securing the source and work area if any condition is suspected to exist that may affect personnel safety. The neutron Capture probe Manager and RADCON will be notified immediately if this situation arises.

6. Ensure that personnel exposures are kept as low as reasonably achievable and below

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WMNW administrative limits for this work.

4.0 ADMINISTRATIVE CONTROL

4.1 RADIATION WORK PERMIT

The facility Radiological Control organization section shall generate an approved RWP for the use of the radioactive source(s) used with the neutron Capture measurement device. All personnel shall read and understand all provisions of the RWP associated with the use of neutron sources. The RWP Acknowledgement sheet must be signed by each individual, indicating that they have read and understand the applicable RWP. This may be accomplished by using the RCIMS electronic dosimetry system. The RWP will specify the radiological worker training required for all personnel involved with the use of the neutron source.

4.2 SAFE OPERATING PROCEDURES

A current copy of the main body of this procedure and applicable appendices shall be located at all locations where the neutron Capture devices are in use and where the neutron sources are stored.

4.3 DOSIMETRY REQUIREMENTS

All personnel associated with or observing the use of the neutron Capture probe shall wear assigned dosimetry if they enter an established radiation area. Dosimetry requirements will be identified on the RWP.

4.4 LEAK TEST REQUIREMENTS

Sealed source leak testing of the source(s) used with the neutron Capture probe shall be conducted immediately before its initial first use and at least every six months by RADCON.

4.5 INSPECTION AND MAINTENANCE OF THE NEUTRON SOURCE(S)

The source custodian or his alternate shall visually check for defects in the outer source encapsulation before its use on any day. Defective or suspected defective equipment or source encapsulation shall not be used and shall be tagged out of service. If, during the use of the source, personnel have reason to believe that the outer encapsulation may have been breached, all personnel in the immediate area will be notified and RADCON notified to verify the integrity of the capsulation. Example; Source NSD-78, is a doubly encapsulated special form source that has been tested under high temperature (2400 °F) for 1 hour, a 20,000 pound crushing force, and under a 10,000 shear force and was shown to not leak. If this source or another special form (49 CFR 173.476) source were simply dropped during normal handling, an emergency would not be declared (unless visual inspection did provide evidence that the capsulation was violated) because the demonstrated strength of the capsulation far exceeds the conditions that could normally be imposed upon the capsule by a handling drop. In the event of a source handling drop, an integrity test would be obtained from HP prior to further use.

4.6 OPERATIONS LOG

An operations log shall be maintained at each location where the neutron source is used. The beginning and ending times that the source(s) is in use will be recorded in this log. A source checkout log may be required if an individual is using the source at a location away from the normal storage location. The following information is required on a source checkout log:

- Source custodian's name
- Source identification number
- Source isotope
- Source activity (Ci)
- Signature and payroll number of individual authorizing use
- Signature and payroll number of responsible source user
- Date and time source is removed from storage
- Destination for source use
- Date and time source is returned to storage
- Signature and payroll number of individual receiving source for storage

4.7 INSTRUMENTATION

Instrumentation for monitoring radiological conditions will be determined and operated by RADCON personnel.

APPENDIX A
USE OF ISOTOPIC NEUTRON SOURCE FOR BOREHOLE LOGGING

1.0 SCOPE

This procedure establishes the requirements for the safe use of radioactive neutron sources associated with the development, testing, calibration, and operation of well logging neutron at well sites. This appendix shall be used in conjunction with the main body of this procedure.

2.0 GENERAL REQUIREMENTS

2.1 PERSONNEL REQUIREMENTS

It is the RADCON's responsibility to assure the safety of all personnel during use of the neutron source. The RWP will state the requirements for Radiological Control Technician (RCT) coverage. The RWP will also specify the radiological worker training required for all personnel who enter the radiation area set up for use of the source.

2.2 SOURCE HANDLING AND ASSOCIATED PROBE EQUIPMENT

The neutron sources to be used are encapsulated isotopic or chemical radioactive sources. These sources continually produce neutrons of several MeV average energy. Gamma ray and neutron detectors are used with this source to make a neutron Capture detecting device. The probe (source and detector) is used with calibration wells to test, evaluate, and calibrate its operation or to provide measurements in boreholes. A logging hoist will be used to deploy the neutron probe device in the boreholes. The neutron probe will be supported by a 7/8-inch logging cable or an equivalent logging armored cable capable of supporting the weight of the probe. Data collection and processing electronics will be used with the logging truck to acquire and interpret the down hole measurements and to provide processed data.

The source capsules will routinely be used from within a removable source holder that attaches to the probe housings. This source holder connects to the logging tool housing by a threaded connection and will be installed or removed from the housing using a tool that allows the user to maintain a minimum 28-inch (71 cm) separation of extremities from the source capsule. The acceptable tool is a socket driver with a minimum 28-inch (71 cm)-long extension. The neutron source materials will be stored within the source holder in the shielded cask when not in use. The dose rate at the surface of any shipping cask will not exceed 200 mrem/h. Storing the source within a source holder will eliminate the need to insert and remove the source capsule from the holder for each use.

2.3 SITE REQUIREMENTS

The encapsulated neutron source is authorized to be removed from the shielding/storage container to be used with the neutron detectors per the signed and approved RWP, when the requirements of the RWP are met. The sources will be stored in shielded shipping casks at the site designated by the RWP or other site control documentation. The shipping cask must either be secured in a locked enclosure or secured to a permanent and not easily movable structure to prevent unauthorized movement or theft.

2.4 USAGE REQUIREMENTS

As low as reasonably achievable (ALARA) principles will be followed in the use of the neutron source. When the source is being used to perform measurements not in a borehole, a temporary radiation area may need to be established and posted, as required by RADCON and the RWP. RCT coverage will be determined by the RWP requirements. Because the expected personnel dose rates are negligible when the source is deployed in a borehole, no special precautions need to be taken during data acquisition.

When personnel are handling the source (such as when the source is being attached to the Capture probe), the shortest interval of time possible should be used. Sources whose on-contact total dose rate exceed 50 mrem/h will be handled using remote implements that provide for a minimum 28-inch (71 cm) separation between the capsule and extremities. Handling of the sources will meet all requirements of the job specific RWP. For the logging probe, the source should be left deployed within the calibration wells between measurements, so that the shielding provided by the well will be taken advantage of while preparing for subsequent measurements. Personnel will maintain a safe distance, as defined by the RWP, between themselves and the source when their proximity to the source is not required. These time, distance, and shielding precautions will minimize personnel exposures.

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